SOCIAL CONSTRUCTION OF QUALITY IN SOFTWARE DEVELOPMENT

Master's thesis
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Tiivistelmä

Laatu, aika ja voimavarat. Näillä tekijöillä ja niiden keskinäisillä suhteilla on ratkaiseva merkitys ohjelmistokehityksen aikana esillenostettujen laatuongelmien käsittelyssä. Vaikka ohjelmistosta paikannetuilla ongelmilla saattaa olla välitön ja konkreettinen vaikutus tuotteen menestykseen, kullekin määritellään oma, erillinen paikkansa hyvän ja huonon laadun jatkumolla. Diskurssilla, argumentaatiolla ja retoriikalla on keskeinen tehtävä kunkin ongelman merkityksen arvoimisessa, siihen kytkeytyvän laadun tason määrittelyssä ja asianmukaisten laatuun vaikuttavien ratkaisujen päättämisessä.

   Tässä työsä tutkittiin sitä, miten ohjelmiston laatua rakennettiin sosiaalisin ja diskurssiivisin keinoin ohjelmistokehitysprosessissa. Työssä analysoitiin tarkemmin sitä, miten ongelmalliseksi esitetyn objektin laatu rakentui sitä käsittelevän diskurssiivisen toiminnan kautta. Tämä tehtiin tutkimalla sitä, miten käsitys laadusta faktualisoitiin sekä sitä, miten se rakentui kehystämisen ja positionnin kautta. Työssä keskityttiin tiettyjen yksittäisten vikaraporttien sisältämän diskurssin analysoimiseen ja tutkittiin millaisia retorisia ja argumentatiivisa keinoja niissä hyödynnettiin. Työssä myös tutkittiin sosiaalisena vaikuttamismenetelmänä toimivan *liittymisen* (enrolment) edistämiseksi hyödynnettyjä diskurssiivisia mekanismeja. Työssä päädyttiin siihen johtopäätökseen, että laatua ei rakennettu yksinkertaisesti tai pelkästään teknisesti parhaiden ratkaisujen varaan, vaan niiden ratkaisujen pohjalle, jotka saivat diskurssiivisen toiminnan kautta eniten valtaa tuekseen.

   Tässä mielessä laadun rakentaminen oli prosessina voimakkaasti diskurssiivinen ja sosiaalinen, heterogeenisen insinööritaidon tulos. Retoriikka, argumentaatio ja liittyminen (enrolment) liittyivät keskeisesti ohjelmistojen laadun muotoutumiseen.

Asiasanat: Sosiaalinen konstruktionismi, ohjelmistokehitys, laatu, SCOT, ANT, CDA, kriittinen diskurssianalyysi, argumentaatio, retoriikka
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Abstract

Quality, time, and resources, these three interrelated factors are significant when dealing with software quality problems escalated during the software development process. Although software problems can have a direct and concrete impact on a product's success, each alleged problem manifests itself on the continuum of good versus poor quality as an individual, isolated, case. Discourse, argumentation and rhetoric are central in the process of assessing the impact of each located problem, and determining where it situates on this continuum. They are also elemental in the process of deciding the appropriate actions for resolving each problem.

The present study investigated the social and discursive nature of software quality construction within the software development process. It investigated how the notion of a problematic object's quality was constructed in the discursive action that dealt with it. It looked at how the notion of quality was factualised, how it figured in the activities of framing and positioning. It focused on the discourse of specific error reports and analysed the rhetorical and argumentative methods used in actual error report texts. It also looked at the ways enrolment as a social method of persuasion was employed in the discourse.

The study concluded that quality was not constructed simply, or solely, by selecting and implementing the technically best solutions, but rather, those that became empowered through discourse. In this sense, the process of quality construction was a highly discursive and social one, a result of heterogeneous engineering. Rhetoric, argumentation, and enrolment played a central role in the shaping of software quality.

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1. INTRODUCTION

Quality, time, and resources, these three interrelated factors are significant when dealing with software quality problems escalated during the software development process. Although software problems can have a direct and concrete impact on a product's success, resulting, at worst, in a negative end-user experience, and severing the user's overall confidence in the product and even the whole product brand, in development, each alleged problem manifests itself on the continuum of good versus poor quality as an individual, mostly, even isolated, case. Discourse, argumentation and rhetoric are central in the process of assessing the impact of each located problem, and deciding where it situates on this continuum. They are also elemental in the process of determining the appropriate actions to resolve the problem.

The present study attempts to shed light on the social and discursive nature of software quality construction within the software development process. In more detail, this study investigates how the notion of a problematic object's quality is constructed in the discursive action that takes place around it. It looks at how the notion of quality is factualised, how it figures in the activities of framing, and how it manifests in the actions of positioning. In sum, this study investigates how quality is constructed in the discursive interaction that occurs within the networks and communities working on the respective products or services whose quality becomes scrutinised and questioned through specific error reports. This study grounds its analysis on the investigation of the rhetorical and argumentative strategies and methods actors employ in the actual error report texts. It also looks at the ways a specific social method of persuasion, i.e. enrolment, is utilised in the discourse. The error report texts, hence, form the central source material of investigation.

When talking about software development, we are not only referring to an intersection of humans and machines (such as programmer and computer, or tester and device) but also humans and other humans: in the case of

commodity development, more specifically, humans who develop software with other humans, for humans. We are talking about professionals acting together in a real world context, making real decisions concerning real products for real consumers. If the decisions turn out to be the wrong ones, the consequences can be costly: to fail a product has a direct impact on an organization's financial results. Although the notion that the software development process builds on social and discursive action may sound somewhat self-evident, what this action in practice entails can remain vague, even to those involved in the process.

In a large software research and development organisation distances between people are as much physical as they are mental – distances in perception as much as comprehension: for example, the further up in management one is, the less visibility one has into the complex reality of the software development process. In turn, the closer one is to the actual software development process, the less visibility one has to the actions of others in surrounding, and even parallel domains. Regardless of how interdependent each entity actually is on the output of the other, understanding the chain of relations between different contributors can be hard to grasp.

The beacons meant to guide the actions of all the participants in a common direction, are the processes: the guidelines, instructions and flow-diagrams, which specify how people should act in different situations. However, the actual tool for interpreting, applying and implementing the processes is human action itself. So far as code is the medium for creating software, language is, in practice, the medium for shaping its quality. The outcome of the decisions and evaluations involved in developing a piece of quality software can be, in turn, interpreted into a simple percentage or shade of green, in some cases even literally speaking a smiley face. Though these indicators constitute visible representations or symbols of quality, it has, in fact, been perceived many a time that the shades of green are not always as green as they initially have seemed. This is visible in the findings made during

later development phases and, for instance, even further down the chain via actual consumer feedback. Many may further wonder why the green was, in the end, so difficult to reach. Looking at the micro-practices, which take place within the framework of implementing the processes can, at best, provide a glimpse into what software development as human action means and give insight into what is the quality being constructed into the products in practice entails.

Quality problems may be the result of many practical factors, such as shortcomings with design accuracy and testing coverage. These factors may even have intertwining cause-effect relationships. However, the focus of this study is not to delve into the investigation of underlying factors per se. Intriguing though they are, investigating each factor would require studies of their own. This study, instead, limits itself to the factors articulated and explicated in the discourse of the primary material investigated in this study, i.e. the error reports. Thus, for example, even if issues with design accuracy could in essence be the background cause of a problem that becomes escalated, this reason is here of interest only so far as it is explicitly given significance within the error report discourse. How people posit the problem is relevant.

1.1 Practical context of the study and its material

The material for this study originates in a software development organisation, which consisted at the time of thousands of people working on IT commodity projects, in some contexts, separately, and, in others, together, either locally or from a variety of locations. The whole organisation comprised a multitude of functions from marketing to human resourcing and subcontracting. However, the actual product creation took place in the sector of research and development. This organisation was also responsible for the quality of the products. The projects themselves combined various types of material and immaterial objects resulting from the realms of software and hardware development. The material being analysed in this study was created in 2007 or

December 2006, and it developed into its final form within the error report handling process during 2007. The material was gathered during 2008.

1.2 General aim of the study

My aim is, at a general level, to investigate how networks of actors come together and construct quality in practice, by looking at how anomalies identified in the quality assurance process are dealt with. According to phenomenological thought (Kuhmonen and Laine 1995: 59), anomalies or abnormalities forms useful entry points to investigating and understanding what is considered *normal*. In this sense, understanding how problems with quality are dealt with, can help understand how unproblematic quality is fathomed. I will look at how notions about quality becomes factualised, and how positioning and framing are utilised in the process of quality construction.

In relation to the above-mentioned, my concrete aim is to study the discourse and related social practices and efforts that people undertake in the process, and, thus, investigate the social, rhetorical and argumentative methods and tactics people apply in order to influence others about courses of action to take in the social process of quality construction around each anomaly. The power to influence others is related to the professional roles participants have in the community, and thus, critical discourse analysis provides a useful approach for viewing social power and discursive influence at work.

I will, firstly, outline the general background of software development and the related paradigms of thought. I will, secondly, introduce contemporary shifts in thought about technology and its relation to society, through the approaches of the social construction of technology (SCOT) and actor-network theory (ANT), which also provide tools for analysing the material. I will, thirdly, elaborate on the setup of the present study, and, fourthly, discuss the methods of rhetoric and argumentation applied in the detailed analysis of the texts in

the source material. I will, fifthly, present the social and organisational context within the source material has emerged and then present the analysis of the material, and, finally, I will conclude with a discussion on the findings.

1.3 Software development process. General background

The Institute of Electrical and Electronics Engineers (1990: 67) defines software development as a set of activities that transform user needs into software products. These activities involve at least the processes of design, implementation and testing. Design refers to the planning of a software solution, implementation to its creation, and testing to the process of assuring its quality. As work practices, these can be interrelated or separate depending on the applied software development model and way of working. As is the case with other fields of expertise, the realm of software development has had to, and continues to, answer to and continually adjust to the requirements set by ever-changing paradigmatic and worldly circumstances.

Software development is generally considered either synonymous with[1] or to originate in[2,3] the field of software engineering. The latter is traditionally, in turn, located within the discipline of computer science (Blum 1996: 172). Constituting a form of mathematics computer science stemmed from the study of formalism, a modernist approach which coincided soundly with the principles of rationalism and scientific positivism that influenced the overall 20th century view of technology development. (Blum 1996: 24-25, 54, 172, 378

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[1] Software engineering refers to the systematic activities which are involved in the design, implementation and testing of software to optimize its production and support (Canadian Standards Association, cited in Lethbridge and Lagarnière 2001: 7).

[2] Software engineering is the establishment and application of sound engineering principles and methods in order to obtain economical, reliable and functional software. (Naur and Randell, 1969; Bauer, 1976, cited Wang and King 2000: 6).

[3] Software engineering refers to the application of a systematic, disciplined, quantifiable approach to software development, operation, and maintenance. It is the application of engineering to software. (Institute of Electrical and Electronic Engineers (Standard 610.12-1990) 1990: 67).

and Convey 1997: 8, 20-23, 26-27.)

As a formal discipline, computer science focused early interest on programming languages. It drew from various mathematical models while targeting to construct axiomatic theories and rules. (Blum 1996: 14, 250, 379.) Gradually, computer science also turned to more practical applications, such as the engineering of computer systems and operating systems (Blum 1996: 14, 379). However, at the same time the engineering field became further permeated by the ideals of science (Convey 1997: 27-28, 32; Blum 1996: 18-19).

As a result, technology became equated with science and technologists with scientists. This dichotomy lead to elevating the value of *the thinker* over that of *the doer*. (Blum 1996: 57, 68, 151; Convey 1997: 27-28.) Accordingly, experts with access to the theories, striving for objective truths were thought to be best placed to deliver the appropriate designs (Convey 1997: 11, 26-28, 30), and engineers were encouraged "to adopt a self-image based on science" (Layton 1971, as quoted by Blum 1996: 57), affirming the individual as an agent of independent reason (Convey 1997: 32)[4].

Nowadays, this self-image is not void of tension. Convey (1997: 30-31) traces this tension to a change in the role of technology in today's society: technology no longer serves solely as a means to an end (something we want), but an end-product in itself. For example, in the realm of commodity development, a mobile phone is not only a means to communicate, but a symbol, an object of wanting, even an extension of the self: "Technologies are implicated in our whole way of being." (Convey 1997: 31)[5]. Similarly, the place of software development has begun to move from that of an introspective, logic-based

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[4] As per Layton's mirror-image twins metaphor, the scientist was originally fathomed as the one who seeks to know, whereas the technologist was depicted as the one who seeks to do. In practice, greater was honoured to the first. (Blum 1996: 68.)

[5] As Convey explains with his example of the automobile. It is not simply a means of getting from one place to another. The car has the cultural implications in values about freedom, independence, and prestige. (Convey 1997: 11, 30.) In this sense, also means and ends can be interdependent(Convey 1997: 11, 31). For example, a mobile phone is not only a means to communicate, but a symbol, an object of wanting, and, finally, an extension of the self.

activity, i.e. *within the computer* to an activity that takes place and provides solutions *within the world* (Blum 1996: 242, 263 and Convey 1997: 11).

Consequently, the notion of what constitutes a working object has changed. Traditionally, *working* refers to a product's conformance to specified standards and objectives. Today, a working object is one that succeeds in satisfying needs of users in-the-world. (Blum 1996: 58, 242.) Whereas the former could be reached through abstract and logic-based work activities, the latter necessarily invites open, dynamic processes that supersede technological considerations (Blum 1996: 58, 242). This reflects respectively on notions of quality, what is scientifically correct is not necessarily that which is valid "in the world" (Blum 1996: 242). Convey calls this the pragmatic turn (Convey 1997: 11, 31). Technology development is expected to embrace and embody the interpretive, pluralistic, social and discursive nature of postmodern reality (Convey 1997: 11, 31 and Blum 1996: 91-92).

It can be argued that, in the end, every design is (and has in fact been) in-worldly, i.e. historically and politically situated (Bowker et al. 1997: xix). It 's success depends upon the relationship between the interpreting, meaning producing, and gap closing aspect of human action and of formalistic tools (Axel 1992, cited in Bowker et al. 1997: 126). Although software development can be similarly argued to have always in practice manifested elements of openness, discursivity, and sociality, organisations have not always recognised this. The chosen models and paradigms of thought, and world-views tend to focus and filter what is visible (made sense of) and acknowledged while determining what is acceptable (see e.g. Augoustinos, Walker and Donaghue (2006: 12, 286-310) for an in-depth discussion of the mechanisms of social cognition and social patterns of perception). Following Blum (1996: 67), however, if we, concede that knowledge, such as that created and applied during software development (Blum 1996: 62), always exists within a context (Blum 1996: 67), in order to understand the nature of this knowledge, we should explore the nature of the context in which it is valid.

A more appropriate, contemporary definition of software development could be that of Vincenti: Software development is "a social activity directed at a practical set of goals intended to serve human beings in some direct way." (Vincenti 1990, as quoted by Blum 1996: 59.)

1.4 Software development models

The tension between the alternate paradigms of technology: rationalism and formalism on the one hand, and pragmatism and postmodernism, on the other, have reflected on the available and applied software development models in organizations. Examples of influential, prevailing development models are respectively those of waterfall and agile. At the time and organizational context of this study, both above-mentioned development models were in use, the latter gradually replacing the former.

In waterfall, each practice within the project's development cycle constitutes a separate, subsequent phase. To achieve its goals (analyse, design, code, test, produce) this model leans on ordered practices and hierarchised knowledge. It emphasises the conceptual nature of design (analyse need and create requirement, design, implement, test, produce, close requirement). (Blum 1996: 251-252, 258.)

In agile development, the development project itself is broken into smaller successive mini-projects called iterations (Cohn 2004: 10 and Larman 2004: 12), each entailing an ensemble of development practices required to reach the set targets at hand (Cohn 2004: 4 and Larman 2004: 12). For example, the 1st iteration may infer analysing the need and solution, designing, programming, testing, and production. The 2nd d iteration may require reviewing the solution and creating additional complementary solutions (Larman 2004: 10). Customer requirements are prioritised and broken down into smaller sub-requirements or user stories, each describing a detailed need and the criteria with which to

evaluate the readiness of the implemented solution (Cohn 2004: 4). The emphasis is on continuous collaboration to achieve goals (Larman 2004: 29).

Although waterfall does not forbid collaboration as a mode of working, nor does agile forbid the application of ordered practices, as Mullins (2007: 320, 725) describes, underlying paradigms have an influence on which ways of acting and practicing are conceived of as valuable. Organisations, in turn, structure and sanction action according to presumptions on what is preferred and valued, which makes alternate ways of acting difficult. Such action can be considered anomalous and result in tensions.

The merit of the agile model is in that it recognises and emphasises collaboration as a central key factor for the successful development of software. It assumes a face-to-face team setup between different collaborators. How people are in practice able to come together when problems touch multiple teams and locations, is another question.

1.5 Relevant software development terms and definitions

The key development practices or functions realised in both models and relevant to this study are depicted in Table 1. Not all functions are relevant for all projects. Although, in practice, the different practices can take place simultaneously (e.g. design and coding), in a different order (e.g. test specification creation versus localization), or be even re-executed after execution of a successive function (for instance, functional testing after exploratory testing, due to problem-solving needs), the functions are here listed in the order they could be initiated in during a project or iteration. Many of the phases are dependent on the initiation of work for preceding functions (e.g. TRUE testing needs software and hardware to test on).

A couple of the definitions and descriptions of relevant terms were located in published sources, the majority were located centrally in Wikipedia. Wherever

not available from the previous two source types, I have defined the terms based on organisational material that is not publicly available (marked with internal and creation date) and my professional experience in the field (Kaukonen 2011). Though the reliability of WIKI as a source for scientific investigation is often questioned, from my professional point of view, the definitions correspond sufficiently to the general conceptions and practicalities that prevail in the field.

Build and integration, and variation Combining the specified software components including code and localisation into a software package. Creating software packages, i.e. images that can be inserted, i.e. flashed into hardware. Variation: enabling and disabling specific components of features, e.g. according to different customer needs. (Kaukonen 2011 and Internal 1.)
Change request (CR) Typically a minor improvement or addition to an approved requirement. Minor refers to the criterion that its implementation should take no more than a couple of days. Larger changes need to be introduced as requirements. (Kaukonen 2011 and Internal 2.)
Exploratory testing Resembles Ad hoc testing (uplanned, random testing) and TRUE testing (see below). Testing for faults and defects against challenging assumptions. Executed without reference to a test specification, though may have certain execution guidelines defined in advance by testing lead. (Exploratory testing n.d.) In the organisation related to this study, exploratory testing was also expected to be followed by a retrospective, which meant evaluating and discussing what had been done and how, in order to facilitate future executions and promote further learning and development of expertise in testing (Kaukonen 2011).
Functional testing Testing the features for generic problems against expectations. Usually done against a form of test case or test specification. Can cover any level (class, module, interface, or system) of functionality. (Software testing n.d..)
Internationalisation Applying coding conventions which make it possible to dynamically variate the software according to the needs of different regions (e.g. time differences), cultures (conventions and preferences, e.g. colours, icons) and languages (linguistic particulars and conventions), cultural aspects of languages (political correctness), characters and fonts (Internal 3 and Kaukonen 2011).
Language variant testing, language testing Testing the feature for language variant-specific problems. These can be functional or localisation related (Internal 4 and Kaukonen 2011.)
Localisation Translation of UI text objects according to the context of the user interface to different languages. Overall look and feel, layout constraints and regional and culture preferences are taken into account. (Internal 5 and Kaukonen 2011.)

Quality assurance Predefined set of activities and methods employed to ensure the quality of deliverables (Internal 6 and Kaukonen 2011).
Requirement and requirement creation The description of what the project is to produce (Davis 1993, cited in Blum 1996: 255). Description of the behavior of the system to be developed. Requirements must be actionable, measurable, testable, related to identified business needs or opportunities, and defined to a level of detail sufficient for system design (Requirements analysis n.d.).
Test specification Textual descriptions, i.e. test cases or use cases defining expected output, such as functionality, for certain inputs. These are followed in scripted testing. (Kaukonen 2011.)
TRUE testing (Trusted and Rewarding, User Experience) Pilot testing executed on sales candidate products by people who represent, or are, potential real world end-users (Internal 7).
Usability, usability study, usability testing Usability usually refers to the elegance and clarity with which the interaction with a computer program is designed (Usability n.d.). According to (Lauesen 2005: 9) usability consists of six factors: 1. fit for use (functionality). The system can support the tasks that the user has in real life, 2. Ease of learning. How easy is the system to learn for various groups of users? 3. Task efficiency. How efficient is it for the frequent user? 4. Ease of remembering. How easy is it to remember for the occasional user? 5. Subjective satisfaction. How satisfied is the user with the system? 6. Understandability. How easy is it to understand what the system does? During usability testing, the aim is to observe people using the product in as realistic a situation as possible, to discover errors and areas of improvement (Usability testing n.d.).
User interface design Determining the look and feel of the feature to make the user's interaction with the device as intuitive as possible. Covers designing its graphical elements, their positioning and overall functional flow of the feature. (User interface design n.d..)

Table 1. Central software development terms referred to in this study, and their definitions

1.6 Previous studies in the field

To my knowledge the present study is the first attempt at investigating the actual discourse utilised in error reports. This is also to my knowledge the first study to investigate how discourse as a social practice is employed within the quality assurance process of software development; how quality is constructed through discursive interaction taking place during collaborative problem-solving events.

The closest study in the subject area is a survey conducted in 2002 in the field of communication studies. In her study, *Communication in the Software Vulnerability Reporting Process*, Tiina Havana (2003) investigated what various stakeholders of a special vulnerability reporting process thought about the way communication took place in the process. Stakeholders included coordination centres, vendors and reporters. Their opinions were gathered via questionnaires and the analysed quantitatively with .e.g. factor analysis. (Havana 2003: abstract, 26-27, 66-67.)

A key finding was that the stakeholders viewed the communication process as one-way in nature. Information was considered to flow from reporters to coordinators or vendors but not in the other direction, and participants claimed they rarely had regular communication with each other. The communication was considered informative in nature. Though this communication setup was intentional, stakeholders felt that the interaction needed to be more intensive. The knowledge about communication procedures and codification systems were also considered by the participants as insufficient. Havana concluded that a two-way symmetrical communication would help make the dissemination and application of knowledge easier. (Havana 2003: 64-67.) However, this could make the communication process more complex and cause challenges for the publicity management of the participants (Havana 2003: abstract, 75-77).

Another study which has looked at discourse practices in the engineering field is by Jarmo Sarkkinen (2006), who investigated the constitution of design discourse within the field of Information technology. In his study, *Design as Discourse. Representation, representational practice, and social practice*, Sarkkinen assessed the interactions between participants in design team meetings, which centred around the planning of a new Information system (IS). Against the standpoints of ethnographic research and critical discourse analysis, Sarkkinen assessed the significance that visual representations (wall charts) and design artefacts had in the process, and described how verbal representations around them where constructed. (Sarkkinen 2006: 61, 62.) He concluded that the design of a new information system is not only a matter of finding technical solutions to given requirements, but also of dealing with complex interactions between representations, their producers and interpreters against the underlying situational, institutional and societal contexts. Hence, design is also a discourse , a matter of contextually bound human interaction. (Sarkkinen 2006: 71.)

These studies assert engineering practices within the context of social and discourse practices. They provide a suggestion on how questions or concerns with collaborative practices can be approached. My hope is to provide a useful addition to the repertoire of studies in this area.

2. THEORETICAL BACKGROUND

The study context comprises the social arena of technology development, and the actions of agents who participate in and reproduce this arena in their everyday practices. Three approaches are used to organise and frame the analysis of events and actions that take place within the specific local reality of this arena. The Social construction of technology, (SCOT), and its spin-off Actor-network theory (ANT) provide the techno-social framework and concepts, whereas Critical discourse analysis (CDA) provides the socio-linguistic approach and concepts that are together applied to the investigation of the material in this study.

SCOT provides a fruitful approach for investigating the development of technology objects. It targets to highlight the relationship between the development of a technology object and the people who participate in the development process. ANT in turn breaks down the developmental story into phases, and provides an analytical tool with which to disclose the decisive moments where one phase shifts to another. It also acknowledges the potential of immaterial objects to function as actors in shaping the direction of an object's development. CDA focuses on the relationship between discourse as social practice and other social practices of influence that participants embark on around the object being developed. It targets to disclose the human struggles that manifest in the interaction around the object of development, and highlights the place power has as a tool in shaping the outcomes.

2.1 Social construction of technology. A criticism of technological determinism

SCOT rose out of a criticism towards preceding 20th century conceptions about the nature of the relationship between humans and technology characterised as Technological determinism: the general notion that the realm of technology

inherently drives and guides, and even supersedes the realm of human action. I propose that one of the factors obscuring the importance of everyday social action in the success of technology development is the paradigm. This is also the backdrop from which SCOT and ANT arose. In order to enable a better understanding of the underlying engineering context of technology development central to this study, I will in the following present the backdrop of technological determinism. This notion has been central in influencing, not only, how the relationship between technology development and human action has been conceived of within the engineering field itself, but also how it has been perceived in society at large.

2.1.1 Technological determinism

Technological determinism, a term allegedly coined by Thorstein Veblen, is the view that technological change determines social progress. It dominated the 20th century understanding about the relationship between the realm of technology and society. Whereas social progress was considered a mere end result of technological development, the latter was considered an independent force driven forward by an inherent, rational logic of its own. (Karvonen 1999: 82 and Smith 1994: 38 and Williams 1974: 5.)

Other systems of thought supported the dominance of technological determinism. These included the ideal of continuous progress, and the principles of evolutionary thought. The first gained popularity already in the nineteenth century. It suggested that technological development was guided by a self-perpetuating imperative of innovation, which drove it towards continually greater technological goals. Stronger perspectives regarded technological development an inevitable and even unstoppable force automatically leading to greater human and social progress. The second line of thought *naturalised* technological development as an evolutionary process. The notion that individual technology had a natural and linear life cycle became deeply built in: new technologies were thought to evolve and replace older ones:

computers were to replace books etc. As superior technology pushed aside its competitors, society was to adapt. (Williams and Edge 1996: 867-868 and Williams 1974: 5 and Chandler 2000: Techno-evolution as 'progress' and The 'Technological Imperative'.)

The techno-evolutionistic view depicted human history, as a series of 'revolutions' which culminated in historical 'eras', each defined by its key technological achievements: the age of machinery, the age of automation, the atomic age, the space age, and the electronic age. (Chandler 2000: Techno-evolution as 'progress') Similarly, transitions from one societal system to another, such as a shift from feudalism to capitalism, were thought to manifest this progress (Chandler 2000: Techno-evolution as 'progress' and Heilbroner 1994: 70).

Reaching each developmental pinnacle entailed solving problems and removing obstacles that blocked the progression of technology on its evolutionary path. The purpose of society was namely to help materialise these goals by implementing necessary social adjustments. Accordingly, new technologies and products emerged as this predetermined logic unfolded, serving as a justification for this requirement. Humanity received an instrumental role in this endeavour. The realm of the technological was ultimately considered the prime shaper of human history itself. (Chandler 2000: Technology-led theories and Williams 1974: 5.)[6],[7]

The ideas and ideals of technological determinism seemed to be applicable to

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[6] Jaques Soustelle's comment about why the atomic bomb was created serves to summarise this line of thought: 'Since it was possible, it was necessary' (Ellul 1964, as quoted by Chandler 2000: The 'Technological Imperative').

[7] Carroll Purcell describes the thought of this era as being permeated by a mystical, 'semi-religious faith in progress' (Purcell 1994, as quoted by Chandler 2000: Techno-evolution as 'progress), 'the notion is that a kind of invisible hand guides technology ever onward and upward, using individuals and organizations as vessels for its purposes but guided by a sort of divine plan for bringing the greatest good to the greatest number' (Purcell 1994, as quoted by Chandler 2000: Techno-evolution as 'progress).

all levels of human existence. Technological determinism, thus, influenced not only general lines of thought about society. Aligned with the ideas and ideals of technological rationalism and scientific positivism it *mechanised* the practicality of existence. Convictions emerged on how ideal society should be structured, how organisations should work, and how human beingness itself should be conceived of and directed. Taylorism, i.e. the approach to scientific management, introduced by Frederick Taylor in the early 20th century, is an early example of this merge. The approach (Taylor 1911) depicted organizations as technologies and collections of rationalised instrumental practices. In order for them to become efficient machines, they were to adopt scientifically proven work processes. These processes were to be broken down further into predetermined series of efficient bodily movements and practices, which were to be embodied by the actual workers themselves.

These notions did not, however, stop at the mechanization of the physical body. Human thought was also to be mechanized. As Convey describes (Convey 1997: 286-287), by reducing human thought to series of propositions and truth predicates, which could be manipulated according to causal laws, it could even become captured and preserved in machine form. Thus the ideal of a machine-like consciousness superior to that of mankind was propagated. The future human would emerge from the unification of human being and machine. (Chandler 2000: Techno-evolution as 'progress'.)

Ultimately, the obsession with technology has led to a way of thinking that is itself instrumental and techno-rational, we see everything, including people, in technological terms as implements to be used and exploited. The dependency on the technological has, in turn, lead us to "*cultivate* a special relationship to technology wherein needs and conflicts are almost invariably formulated as technical problems requiring technical solutions' [what are usually called 'technical fixes']". (Mowshowitz 1976, as quoted by Chandler 2000: The 'Technological Imperative', emphasis added.)

2.2 Social construction of technology

Technological development was not, in the end, able to provide the needed solutions to deep-seated social and human challenges. Additionally, it became evident that ethically unchecked development had adversary effects on human well-being. Towards the end of the millennium the conception of the technological as a realm beyond the ethical became questioned, and consequently, the prevailing notion of technology as predestined determiner of social progress was also brought under scrutiny. Critically and pragmatically oriented social and human sciences such as sociology, social psychology, and history began to focus increasing attention towards deciphering the relationships between these realms. The realm of technological development and its unproblematic social implications were questioned and opened up for study. (Williams and Edge 1996: 866-869.)

The events surrounding the emergence of central technologies were reviewed against their social and historical contexts. As a result technologies were demonstrated to be the product of social and human action rather than that of internal evolution. The tables were turned. Instead of being a mere effect of technological development, social and human action was itself depicted as the prime shaper of technology. (Williams and Edge 1996: 866-867.)

However, as Convey (1997: 76) notes, the old divide between the realm of the technological and the social is, to this day, still readily mirrored in education. Technology is studied in the field of engineering, whereas its critical evaluation is generally restricted to the humanities. Nevertheless, these separate traditions became conjoined in actual transdisciplinary research which can be grouped under the umbrella term The social shaping of technology (SST). Finding a common interest in SST researchers agreed that the `black-box' of technology should be opened in order to disclose the socio-economic factors that influence the appropriation and development of technologies (Williams and Edge 1996: 866).

The first studies into the relationships between societal and technological elements date back to *socio-technical system studies* in the 1950's (Henriksen et al. 2004: 50 and Ropohl 1999). However, the majority of contemporary influential work in the area can be attributed to constructivist work initiated in the 1980's (Henriksen et al. 2004: 50).

Constructionists start from the claim that referring to technological elements alone cannot adequately explain technology development: "Technology does not spring, *ab initio*, from some disinterested fount of innovation" (Bijker and Law 1992: 11). Instead, it is shaped in the interaction between interconnected technical, economical and social factors. (Bijker and Law 1992: 11). Constructionist research began also taking artefacts of technology as a starting point for social study.

Two central constructionist approaches are relevant to this thesis: social construction of technology (SCOT) and actor-network theory (ANT). Building on the sociology of science and sociology of scientific knowledge, which emphasise the socially constructed nature of scientific truths, Pinch and Bijker established SCOT as a theory and method for analyzing the historical and social circumstances influencing the development of technologies. They aimed to explain how and why particular technologies triumphed at a particular time. (Williams and Edge 1996: 869-870.) A central conjoining idea in SCOT is that innovation evokes different interpretations of a technology and that these interpretations are negotiated by people within their social contexts (Bijker and Law 1992: 3). In this sense, technological development cannot be understood as linear but rather relational and relative to surrounding social factors (Bijker 1992: 6, 75). The direction of innovation depends upon the social world where it emerges: "Technologies do not… evolve under the impetus of some necessary inner technological or scientific logic. They are not possessed of an inherent momentum. If they evolve or change, it is because they have been pressed into that shape." (Bijker and Law 1992: 3).

Significantly, choices taken could have differing implications for society and for particular social groups (Williams and Edge 1996: 866). The direction of innovation is unpredictable. Different paths are available and these may lead to different technological outcomes. In another setting the resulting technology could have been totally different. (Dugdale 1999: 320 and Williams and Edge 1996: 866.)

Technologies are born out of conflict but technologies also embody compromise (Bijker and Law 1992: 3, 9). In this sense technologies are also embodiments of political power. "Politics, economics, theories of the strength of materials, notions about what is beautiful or worthwhile, professional preferences, prejudices and skills, design tools, available raw materials, theories about the behavior of the natural environment -- all of these are thrown into the melting pot whenever an artifact is designed or built." (Bijker and Law 1992: 3).

SCOT has been used to study the shaping of various technologies. One of its classics is Bijker's investigation on the social construction of popular, everyday objects. In his book Of Bicycles, Bakelites and Bulbs, Bijker (1995), for instance, looks at how corporate interests drove the dissemination and appropriation of specific fluorescent lighting solutions over others, how patent battles affected the conceptual shaping of early forms of plastics (Bakelite versus its rival, celluloid) and how different social groups influenced the shaping bicycles by redefining and resignifying their key features.

In the social constructionist tradition itself, different levels of constructionism are entertained varying from an emphasis on co-construction between social and technological realms in technological development to a more socially deterministic orientation. However, the common notion is that social and the technological realms influence and shape each other to varying degrees. Technologies are, hence, products of heterogeneous engineering. (Bijker and Law 1992: 3, 11-12.) As Bijker and Law proclaim against extreme forms of

constructionism in general: "All relations should be seen as both social and technical... This, then is the postulate of heterogeneity… suggesting that both social determinism and its mirror image, technological determinism, are flawed. This is because neither the (purely) social nor the (exclusively) technical is determinant in the last instance. Indeed, what we call the social is bound together as much by the technical as by the social... Social classes, occupational groups, organizations, professions -- all are held in place by intimately linked social and technical means." (Bijker and Law 1992: 290.)

SCOT analysis typically proceeds *outwards*, starting from the technological artefact towards the context shaping it. It attempts to identify the central branch-points or historical moments where choices influencing the direction of the artefact's development were made, and, then, reconstructs the social events and factors that shaped it. (Williams and Edge 1996: 869-870.) However, as an orientation stemming from the social sciences, SCOT has been criticized for paying too little attention to issues of power, when for example explaining why certain versions of technologies became to dominate over others (Klein and Kleinman 2002: 30). This criticism relates to the outward approach, the fact that SCOT traditionally takes as its starting point particular technologies rather than the social and organizational contexts were technical change is introduced (Klein and Kleinman 2002: 30 and Williams and Edge 1996: 870). However, alternate approaches, such as the sociology of industrial organizations have filled this gap, for instance, by looking at how new technologies introduced in the work place exert control, replace work practices impact, or displace the workforce and its skills. Critical studies of technology policy, in turn, have investigated the formation of work policies and looked at how forces and interests are aligned around them. (Williams and Edge 1996: 870-871.)

Finally, SCOT has been criticised for perpetuating determinism itself: Describing technology as such is seen as a process of determining it (Woolgar 1996: 88). The criticism centres on the question whether social constructionism

as a paradigm, in general, can ever be free of the determinism it questions.

2.2.1 Central concepts

The social constructionist method (SCOT) centres around four interrelated concepts, the fourth being a later addition to the framework. These are relevant social groups, interpretative flexibility and stabilisation, closure, and technological frame. A fifth term central for this thesis is the notion of workability.

Technology development can be considered as a process, in which multiple social groups, each attributing a specific interpretation to an artefact, negotiate with each other over its design (Klein and Kleinman 2002: 29-30 and Bijker, Hughes and Pinch 1987: 13). Relevant social groups, in turn, comprise of all the agents who attribute meaning to the artefact (Kline and Pinch 1999: 113). What constitutes a specific *relevant social group* is that its members *share the same set of meanings* and thus mental constitutions regarding a given technological solution (Bijker, Hughes and Pinch: 1987: 30). Ultimately, relevant social groups do not only perceive different aspects of a solution. The meanings or interpretations given by the relevant social group actually constitute the artefact. There are, in turn, as many artefacts as there are social groups. (Bijker 1995: 77.) Additionally, an artefact is dynamic and ever changing. Each perceived problem and solution impacts the development of the artefact. (Bijker 1995: 52.)

Interpretive flexibility refers to the openness of a technology to, not only represent different interpretations, but to also embody them. How these interpretations influence the direction of a technology's design depends on the social circumstances of development. (Bijker 1995, 77 and 270.) There are points where social factors of a *selection environment* enter and scrutinise the available interpretations. These exemplify key moments of *interpretive flexibility* where ambiguities in the technological development occur i.e. where

technologies could be designed in more than one way. (Williams and Edge 1996: 866, 869.) This flexibility exists until consensus of some form concerning the meaning of an artefact occurs between different groups (Klein and Kleinman 2002: 30).

Each artefact is described as being constituted by a relevant social group and the description includes a specification of what counts as working in that group (Bijker 1995: 75). A technological frame refers to the shared cognitive frame that structures a relevant social group (Bijker 1995: 123, 126). It builds up when interaction around a specific artefact begins (Bijker 1995: 123). It constitutes the members' common interpretation of an artefact. Similarly to a Kuhnian paradigm, a technological frame originates in the theories, practices, tactics, goals and means shared by the group in relation to a technology that, implicitly or explicitly, structure the thinking of group members, their problem solving, strategy formation, and related design activities. (Bijker 1995: 123-126.)

Technological frames contain resources for structuring interactions, including technological goals, key problems, testing procedures, problem solving strategies, requirements, and the respective exemplary facts (Bijker 1995: 123-125). They not only define conceptual aspects of the social group but also its actions. The range of actions available for members and the level of dynamicity in the group depend on the degree of inclusion members have in the frame. (Bijker 1995: 143.) A high degree of inclusion suffices to limit the options and constrain the dynamics (Bijker 1995: 192).

A technological frame may promote certain actions and discourage others: "Within a technological frame not everything is possible anymore (the structure and tradition aspect), but the remaining possibilities are relatively clearly and readily available to all members of the relevant social group (the actor and innovation aspect)" (Bijker 1995: 192). In this sense, technological frames act both as a source for change and development and as a constraint on

action: they embody power (Bijker 1995: 263-264). When the degree of inclusion is low, group members may even be part of more than one frame (Bijker 1995: 141-143).

A multigroup design process can experience controversies when different interpretations lead to conflicting images of an artefact. Design continues until such conflicts are resolved and the artefact no longer poses a problem to any relevant social group. When the process achieves closure, no further design modifications occur, and the artefact stabilizes in its final form. A final decision occurs. (Klein and Kleinman 2002: 30.)

Closure takes place if and when conflicts over the interpretation are resolved. Closure is, thus, resistance to any further change. The mechanism of closure may be signalled explicitly. One form it can take is *rhetorical closure*, for instance, simply declaring that no additional design is necessary. (Klein and Kleinman 2002: 30 and Bijker 1995: 85- 86.)

When referring to obsolete technology, closure is easier to conceive of. The Penny Farthing bicycle in Bijker's book (1995: 271) represents such an example. Though in such cases closure is irreversible, unlike the Gestalt type Kuhnian switch, it can in some cases be reversed. Especially more recent technologies which become shaped and stabilised further in use problematise the notion of closure, This is because unlike the Kuhnian paradigm technological frames comprise heterogeneous elements, i.e. not only psychological factors, but artefacts. Also, related social factors, including power relations, and ever changing values influence the shaping process. (Bijker 1995: 271-272.) Closure may be a temporary consensus (Bijker 1995: 85, 87-88) or it may resist being reached, with development lingering in stages of stabilization (Misa 1992: 121).

The further into the stabilisation process a technological frame proceeds, the less room for movement it permits. It looses its interpretive flexibility. As the

frame becomes institutionalised, so does its artefact and the meanings attributed to it. Additionally, the structures and processes and organizational constraints associated with the frame, and even the identities of the relevant social groups, i.e. the ways they act, think and interact, become fixed. (Bijker 1995: 86, 263-264, 271.) As *dominant artifacts* (Bijker 1995: 271) reflecting the attributes assigned by one social group, are diffused, they further impact society. (Williams and Edge 1996: 874). Additionally, relevant social groups have, in building up the technological frame, invested such a large amount of resources in the artefact that its meaning cannot for this reason be changed easily (Bijker 1995: 282). Interpretive flexibility becomes, accordingly, curtailed by closure (Bijker 1995: 87).

If new challenges and problems surface, closure may be overturned. In such cases interpretative flexibility can re-appear. (Bijker 1995: 85, 271.) Constructivists are, hence, also interested in the question of how and under what circumstances the black-box of technology is reopened (Bijker, Hughes and Pinch 1987: 5). It is important to also note that change does not necessarily mean overturning closure. Artifacts may branch out further and stabilise into new separate, working, artefacts, which may exist alongside each other (Bijker 1995: 75) (for example, a satellite phone, a desk phone, and a mobile phone, or a mobile phone and a tablet PC).

Workability, hence, constitutes a central determiner for the success of technology development. In this study, I equate quality directly with the notion of workability. According to SCOT, working and non-working artefacts are socially constructed assessments, rather than intrinsic properties of the artefacts (Bijker 1995: 75). Additionally, what is working for one may be non-working for another. Thus it is important to identify the target relevant social group for whom the successful product is targeted to work, and comprehend what constitutes successful quality for them

The notion of successful workability in commodity development is, in practice, ultimately, measured by customer satisfaction. In practice, understanding

what factors are emphasised and relevant for the customer is central for success. Optimal quality is, however, also a question of resources, time and cost. For example, if a product's life span is in practice three years, but the product is designed to last ten years, this could be considered too good. Too good quality can, then in some cases constitute a problem rather than a benefit, but similarly also is the case with too bad quality. Also, identifying significant quality factors in relation to competitors is important. The most controversial situation is probably one where an object that was internally considered to have reached a good level of quality, turned out to work poorly for customers. Bijker (1995: 240-241) provides such an example with his analysis on the development of fluorescent lighting: two relevant social groups consisting of lamp manufacturers and electricity producers, designed a lamp that worked well for them, but not for their consumers.

Within the realm of software development, quality, and, hence, workability, is dissected into sub areas. These are for instance, language quality, performance quality, and functional quality. Issues located in these areas are considered to relate to predetermined indicators and set criteria, i.e. designed quality. They are, hence, considered as errors and dealt with through the relatively efficient error handling process. Usability issues, issues with problematic design, though, in essence, also significant for the experience of a commodity's quality are not by default considered as errors, or, thus, dealt with normally via the error handling process, since they are considered to require improvements to already designed quality, not corrections to incorrectly implemented features. In practice workability is a result of stabilisation, and quality is thus a function of what is considered to be accepted as workable.

2.2.2 Research examples

The influence of social and structural elements on the construction of artefacts in the realm of the technological is further demonstrated by Latour and Woolgar in the book Laboratory Life (1986). Using an ethnographic method of investigation, i.e. observing scientists at their work (e.g. Latour and Woolgar

1986: 18, 28 and 153), Latour and Woolgar disclosed the social, economic and political nature of fact production. They showed how scientific facts were constructed as a result of networks, alliances, economical rewards, such as investments, and support from significant authorities, who lent their voice to promote certain interpretations and knowledge claims. (e.g. Latour and Woolgar 1986: 198-199, 207-210, 227.)

Credibility was attained by the rhetorical operation of convincing others (Latour and Woolgar 1986: 200). Facts were as if as good as the networks which constructed them, and the meaning of objects depended on that assigned by the network (Latour and Woolgar 1986: 110-111). Latour and Woolgar found that the social factors that influenced fact construction disappeared once the fact was established. Social factors were, however, resurrected when things went wrong. (Latour and Woolgar 1986: 23.)

2.3 Actor-network theory

Similarly as technological determinism, social constructionism has also been criticised for reductionist tendencies, i.e. for accentuating the primacy of social elements over technological considerations in the shaping of technology (Bijker, Hughes and Pinch 1987: 108-109). The act of mutual and co-construction is emphasised in actor-network theory. (Law 2000: 854-856 and Callon 1987: 97.)

Actor-network theory, sometimes abbreviated to ANT, is a sociological theory whose development is attributed to Bruno Latour, Michel Callon and John Law (Allen 2004: 171). Also known as the sociology of translation, ANT originated and grew out from an attempt to understand the microprocesses of technological innovation and scientific knowledge-creation (Law 2000: 854 and Mähring et al. 2004: 211).

An actor network is a web in which elements of any type can be included:

technological artefacts, humans, organisations, institutions, even integrated circuits and microbes (Williams and Edge 1996: 65). All parties are called actants. ANT assumes that all networks are socio-technical in nature containing components of technology or humans and that they are in this sense heterogeneous. (Hanseth, Aanestad and Berg 2004: 118.) It visions all as each other's interactive effects (Law 2000: 854 and Callon 1987: 93, 97.)

ANT provides an approach for understanding how diverse networks of aligned interests are formed. It outlines how actors form alliances by enrolling other actors, and how they invoke non-human actors to strengthen such alliances and secure their interests. (Mähring et al. 2004: 213.) ANT also investigates the strategies different actants deploy in order to create and maintain stable networks of sociotechnical relations (Allen 2004: 171 and Callon and Law 1992: 21).

Michel Callon's classic paper *Some elements of a sociology of translation: domestication of the scallops and the fishermen of St Brieuc Bay* (Callon 1999) exemplifies the conception of such a network. Callon analysed the progression of a project aimed at increasing the stock of scallops through their cultivation. Its success depended on the mutual efforts of local fisherman and the scallop larvae in addition to the researchers themselves. All elements, whether they were animate or inanimate were viewed as significant actants. And the success of the project required co-operation from all of them: if the scallop larvae refused to enter collector baskets, their cultivation would not be possible, if fishermen refused to refrain from fishing, they would endanger the efforts to cultivate the scallops.

ANT considers entities to acquire their form and attributes as an outcome of their relations with other entities. Divisions or distinctions are understood as effects, "they are not given in the order of things." (Law 1999: 3.) For example, groups and organizations can be thought to be held in place by a variety of social and technical means (Bijker and Law 1992: 291).

Actor-Network theory applies a principle of generalized symmetry, which integrates human and non-human actants (e.g. artefacts, organization structures) into a common conceptual framework (Callon 1986: 201) AND (Hanseth, Aanestad and Berg 2004: 118). Registers are not changed when moving from technical to social aspects of the problem studied (Callon 1986: 201). Instead, social and technological factors form a type of seamless web (Bijker 1992: 97). They are similarly attributed equal amounts of influence and agency (Law 1999: 3 and Callon 1986: 201) . The aim is to explore the processes and mechanisms which hold the system or network together and investigate how human and non-human participants organize and produce effects such as inequality, power and organization, while treating them symmetrically and impartially (Callon 1999: 80-82 and Law 2000: 855 860, 863).

ANT aims to be a "relational and process-oriented sociology" (Law 2000: 862). However, according to Latour, ANT is not a theory of the social. Rather, it is a theory of circulating fluids (Latour 1999: 22). ANT attempts to develop a framework that bypasses questions of social construction (Latour 1999: 22), which it considers to be a form of reductionism (Law 2000: 856). This is because, according to Law, constructionism and technological determinism share a similar type of agenda in that they each seek to establish either machines or humans as the ultimate determiner of the other (Law 2000: 856). ANT contrasts itself further with traditional sociological frameworks by abandoning pre-established social categories which it considers to obscure visibility on interaction and change taking place within the co-constructed actor network (Callon 1987: 99-100).

ANT has been criticized for assuming that technologies and humans are essentially the same, and for, thus, being amoral (Latour 1999: 16 and Hanseth, Aanestad and Berg 2004: 118). ANT, however, suggests that, from an analytical stance, social agents of any type are never located in bodies or bodies alone. In a relativistic sense, even an actor itself can be considered a

"patterned network of heterogeneous relations". (Law 2000: 858.) All actants deserve to be treated in a symmetrical fashion.[8]

ANT has been applied to investigations on sociotechnical change in IT research (Allen 2004: 171). Here it addresses the role of technology in social settings and the processes by which technology influences and is influenced by social elements in a setting over time (Faraj, Kwon and Watts 2004: 189). It has been applied to investigations in IT development, IT-enabled organizational change, computer-mediated communication, and infrastructure standards (Walsham 1997, cited in Allen 2004: 171). Work in this field largely focuses on the microprocesses of interaction, (Williams and Edge 1996: 64 and Law and Hassard 1999: 17). For example, ANT has been utilized in the investigation of newsroom persuasion and fact construction practices (Hemmingway 2008), and within the field of ICT (information and communication technology), in research on how database systems are appropriated in organizational contexts (Dori 2002: 87-105). ANT has also been applied to research on *goal targeting systems* multiagent artificial intelligence as well as knowledge management systems. Since it does not distinguish between human, animal or technological actants (or animals) or machine systems (artificial intelligence), human-machine systems can be viewed within the same framework. (Law 2000: 855 and 863.)

ANT has been criticised for focusing on local and contingent elements of sociotechnical change, paying little attention to broader social and cultural processes (Allen 2004: 172.) It has similarly been criticised for ignoring the explanatory value of social theory in its research: attributing too much power to individual actors, ANT has, according to critics, resorted to post-hoc explanations and descriptions on events and developments. (Russel and Williams, cited in Williams and Edge 1996: 890.)

[8] For example, a machine is also a heterogeneous network, i.e. a set of roles that are played by technical materials but also by human components such as operators, users and repair-persons. This also applies to a text. These are networks which participate in the realm of the social. Organisations and institutions are also precariously patterned roles played by people, machines, texts, buildings, which may each offer resistance. (Law 2000: 858.)

Much of early ANT research involved micro-level studies that focused upon the R&D laboratory or emerging technological fields, in which broader institutional contexts were fluid (Russell and Williams 1988, Rosen 1993, Russell 1994, cited in Williams and Edge 1996: 870). Then again, ANT has been also recognized as having a potential for understanding the complex social interactions associated with IT. For example, recent ANT research has shown interest in the relative stability of larger scale structures and practices and focused on the context of innovation. (Law and Callon 1992, Callon 1993, cited in Williams and Edge 1996: 870.) The concern with the stabilisation of related socio-technical systems is considered as an attempt to engage with other traditions in the field. (Law and Bijker 1992, cited in Williams and Edge 1996: 870.)

Actor-network theory, however, also remains sceptical about the influence and nature of broader social and economic structures of power. It considers technologies and social systems to be strongly malleable to local actors, and continues to insist that actors have a primary role in their shaping by continually create the world anew. (Latour 1983, 1986 & 1988, cited in Williams and Edge 1996: 870.)

2.3.1 Central concepts

ANT terms build further on the process of interpretation and stabilization providing concepts which help elaborate the strategies actors (actants) use to build networks and actualise certain frames. The dominance of a specific frame over others depends on how the key actors are able to use their resources to impose themselves and their interpretations on others. ANT groups the related activities and the event chains they form during these efforts under the process of translation.

Translation refers to the variety of methods actants utilize to impose (Callon 1999: 71), or, as Latour more subtly puts it, interest others about their

conceptions of a situation (1987, cited in Faraj, Kwon and Watts 2004: 190). The involvement of others may be necessary in order to gain support for a fact, or further, to build a machine. (Latour 1987, cited in Faraj, Kwon and Watts 2004: 190). Translation is the mechanism by which the social and natural worlds progressively take form, leading towards a situation where certain entities control others (Callon 1999: 81).

During the process of translation the identities of actors, the possibility of interaction between them and the margins of mobility are negotiated and delimited (Callon 1999: 68). As the project may require the involvement of different actants with diverse interests and motivations, those seeking coalitions attempt to align the interests and interpretations of the others with their own (Callon 1999: 70-71).

Alignment, displacement and control constitute some of the methods actants may draw on within the process of translation (Callon 1999: 81) forming translation chains (Latour 1999b: 311). Once an innovator's beliefs and interests are materialized through various forms of inscription and technical arrangements, networks of actors can begin to react to them. (Monteiro and Hanseth 1997, cited in Faraj, Kwon and Watts 2004: 190). The negotiations between different actors result in a situation in which certain entities, at least temporarily, control others (Callon 1999: 81).

Any type of technology development from internet browsers (as in Faraj, Kwon and Watts 2004: 190) to mobile phones may entail negotiations between multiple translations. However, continuous controversy among alternate interpretations would hinder implementation of any of them. Change can, thus, only take place when a stabilised space of negotiation is cleared. This entails constructing a global network, encompassing a set of relations between the actor and its neighbours. This space allows for the accumulation of resources and time needed for the successful stabilization and implementation of a technological interpretation. (Callon and Law 1992: 21-22.)

The process of translation is dissected into four moments or phases of translation. Callon's study *Some elements of a sociology of translation: domestication of the scallops and the fishermen of St Brieuc Bay* (Callon 1999) provides helpful examples for each. The first stage called problematisation, involves the initial steps towards creating an actor-network. The actor defines the related goals, and the relevant actants, and also identifies the initial obstacles to reaching these goals. The actor, then, drafts negotiable visions, consistent with personal interests, regarding the identities, relationships and goals of the different actors. (Callon 1999: 68-70.) In Callon's investigation the goal of the translation process was to find ways to capture scallop larvae. Parasites constituted an identified obstacle to reaching this target. (Callon 1999: 74) The researchers, i.e. initiators, identified, in turn, scallop larvae and the fishermen as relevant actors in the process (Callon 1999: 69).

During the phase of problematisation initiators further position themselves within the setup as indispensable resources and *obligatory passage points* through which other actors must pass in order to fulfil their interests (Callon 1999: 69-70). In Callon's case, the researchers sought to become indispensable by firstly defining what were the problems for the actors and then proposing that these could be resolved if the actors accepted the researchers investigation as the obligatory passage point' (Callon 1999: 70).

The second stage is interessement, which aims to confirm the validity of the problematisation and the alliances it implies (Callon 1999: 73). It involves locking new alliances into place and cornering entities to be enrolled (Callon 1999: 71-74). Initiators try to impose and stabilise the identities of actors by convincing them that their interests are aligned with those of the initiator. Various devices and incentives, may be introduced to ensure they are willing to overcome any obstacles hindering their inclusion into the actor-network. (Callon 1999: 70-72 and Mähring et al. 2004: 214.) In Callon's case, various devices, such as graphs, curves and publications figured, on the one hand, as 'indisputable' evidence on the decline of the stock of scallops, and on the other

as proof about the benefits of proposed solutions (Callon 1999: 73).

If interessement is successful enrolment takes place. During this third stage, actors are enlisted in the newly created actor network and their roles are determined. (Callon 1999: 74.) In Callon's case, these enrolled actors were the scallops which anchored themselves, the fishermen who were persuaded that collectors could help restock the Bay and colleagues who believed in the anchorage (Callon 1999: 75-76).

Initiators utilise various strategies to convince other actants to embrace the ideas underlying the growing actor network and involve themselves as active participants of the project (Mähring et al. 2004: 214): "multilateral negotiations, trials of strength and *various* tricks accompany the *interessements*" (Callon, 1999: 74, emphasised word *various* added). These serve to impose order (Callon and Law 1982, cited in Allen 2004: 183-184), which, in turn, enables actants to succeed (Callon, 1999: 74). In Callon's case (Callon 1999: 76) physical violence (against the scallop larvae's predators), seduction, transaction, and also consent without discussion were applied.

In the final stage of mobilisation enrolled allies act towards achieving the goals. Reality is displaced, transformed and reassembled. Various methods of control and persuasion are used to ensure continued support for the network, and a constraining network of relationships help to stabilize it. (Callon 1999: 76-79) If the network and its underlying ideas are no longer considered controversial, they become institutionalised (Mähring et al. 2004: 214). In Callon's case successful mobilization would have lead to proving that Pecten maximus exists as a species which anchors itself; the fishermen would have supported the experimental project or repopulation and colleagues would have agreed that the results obtained are valid (Callon 1999: 79).

Now at the end of the four moments described, a network has been built. Though, the prevailing consensus and the alliances can be contested at any

moment (Callon 1999: 79), at the end of the process, if it is successful, only voices speaking in unison will be heard (Callon 1999: 81). Callon's process of translation suits the analysis of error reports with their narrative-type progression, and it suits the current theme of technology well, especially with its focus on human and non-human participants.

2.4 Critical discourse analysis

SCOT and ANT both share the notion of reality as a construction resulting from a series of social interactions. In order to understand the way certain outcomes and conditions are formed, Michel Foucault emphasizes the place of power in their construction. To understand how power works, Foucault encourages one to start by looking at the micro-mechanisms of power. These comprise also the subtle influences, which impact people in everyday life: how the mechanisms of power are "invested, colonised, utilised, involuted, transformed, displaced, extended, etc." (Foucault 1980: 59, 99, 100.) The study of the micro-mechanism of language and the social world, in turn, come together in critical discourse analysis.

Critical Discourse Analysis (CDA) is a multidisciplinary approach to the study of discourse (van Dijk 1993: 252). It stems from an interest in how dominance is reproduced in discursive practices (van Dijk 1993: 250). Against traditional forms of language study, CDA takes as its starting point the view that language is itself a form of social practice (Fairclough 2001b: 20) that applies power to reproduce social relations and to position people in relation to each other (Fairclough 2001b: 32-33).

The central concept of discourse in the CDA framework can be elaborated by contrasting it with that of non-critical approaches. At the non-critical end of the continuum, is the textual approach which regards discourse simply as extended samples of written or spoken language. Middle point interactionist views, in turn see discourse as instances of interaction taking place within a

certain situation or context between reader and writer, or speaker and addressee. It categorises discourse, accordingly, into various types, as for example, classroom discourse, advertising discourse and newspaper discourse. (Fairclough 1992: 3-4.)

At the critical end of the continuum is the social analytical view of discourse inspired by Foucault. Discourse refers here to *the domain of statements* realised through various systems of representation. (Fairclough 2003: 123-124 and Fairclough 1992: 2-4.) Discourses are particular ways of representing some part of the world (Fairclough 2003: 17). They are considered frameworks for structuring knowledge and social practices. For example, medical science constitutes a particular discourse within the domain of health care. Within a particular domain there may however be multiple discourses. For example, in the area of health care, one could be the alternative discourse of homeopathy. However, as in the case of medical discourse, certain discourse may be more dominant than others. (Fairclough 1992: 3.) In addition to knowledge, power is, thus, also central to this view of discourse. Discourses relate to power in many ways, Firstly, discourses compete with each other for hegemony (Fairclough 1992: 51). For example, homeopathy can be viewed as the struggling discourse. Secondly, discourses exert power internally. They construct and constitute social relations by positioning people in different ways as social subjects. For example, medical science assumes particular positions for doctors and others for patients. (Fairclough 1992: 3-4, 44, 64.)

Social reality is a field of discourses. Though discourses may compete parallel or against the other, they may in some cases complement one another (Fairclough 2003: 134). Social reality can, respectively, be realised in infinite forms, but when stabilised, particular forms ultimately suppress others (Jokinen, Juhila and Suoninen 1993: 11). Whereas power produces knowledge, by means of discourse, knowledge, drawn upon in discourse , induces effects of power, influencing existing relations of power, and, thus, shaping social reality (Foucault 1980: 51-52 and Fairclough 1992: 12, 36).

Regarding different versions of discourse analysis, a regular division is that between textually oriented approaches, which focus on detailed descriptive analysis of texts and socio-theoretical approaches which look at the social effects of discourse (Fairclough 1992: 1-4). Both approaches have shortcomings in the way they deal with language. Though the latter acknowledges the importance of discourse in the social world, it, however, usually pays little attention to detailed analysis of its linguistic or other semiotic (e.g. visual) embodiments. (Fairclough 2003: 2-3 and Fairclough 1992: 3.) The former, i.e. textual analysis alone, however, fails to see beyond the text. It does not address the role texts play in social struggle or the tensions that affect processes of text production and interpretation. (Fairclough 1992: 2, 28-29.)

Norman Fairclough's version of Discourse analysis coined Critical Discourse Analysis (CDA) is an attempt to unite linguistic and social analyses into a common framework (Fairclough 1992: 1-3). Though CDA stems from criticism to limitations of critical linguistics, Fairclough notes that "no real understanding of the social effects of discourse is possible without looking closely look at what happens when people talk or write." (Fairclough 2003: 3). Texts as elements of social events have causal effects. They influence our beliefs, attitudes, values, etc. They also have longer-term causal effects shaping, for example, identities in terms of gender or consumerism. Texts also bring about change. As we learn from them, they can bring about changes in our knowledge. In sum texts have causal effects upon people, actions, social relations, and the material world. These effects are, in turn, mediated by meaning-making. (Fairclough 2003: 2-3, 8.)

Though text analysis is an essential part of discourse analysis, critical discourse analysis is not reducible to mere linguistic analysis of texts (Fairclough 1992: 3). Language is a multifunctional social practice: it simultaneously represents reality, enacts social relations and establishes identities. Thus, a fruitful analysis of discourse necessitates social analysis (Fairclough 1992: 8-9; Fairclough 2001b: 21 and Fairclough 2003: 2-3.)

In CDA, discourse links the different layers of social reality to each other. Any instance of discourse is simultaneously a dialectical relationship between three facets: firstly, it is a piece of text, secondly, it is a discursive practice, which draws upon different conventions of production, distribution and consumptions (e.g. the discourse of newspaper or biology), thirdly, it is a social practice and as such, part of wider sociocultural structures and practices (organisational and institutional circumstances) manifesting political and ideological meanings. (Fairclough 1992: 4, 63-64-67, 72-74.)

The image below adapted from Fairclough (1992: 73) depicts the relationship between the three facets within the context of this study. The error report texts constitute the level of text, the error handling practice constitutes the discourse practice against which the contents of the texts are interpreted and the software development practice constitutes the social practice against which the former facets can be understood and explained.


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        ┌─────────────────────────────────────────┐
        │  ┌───────────────────────────────────┐  │
        │  │             TEXT                  │  │
        │  │        Error report text          │  │
        │  └───────────────────────────────────┘  │
        │      DISCOURSE PRACTICE                  │
        │      Error handling practice             │
        │  ────────────────────────────────────   │
        │       SOCIAL PRACTICE                    │
        │   Software development practice          │
        └─────────────────────────────────────────┘
```
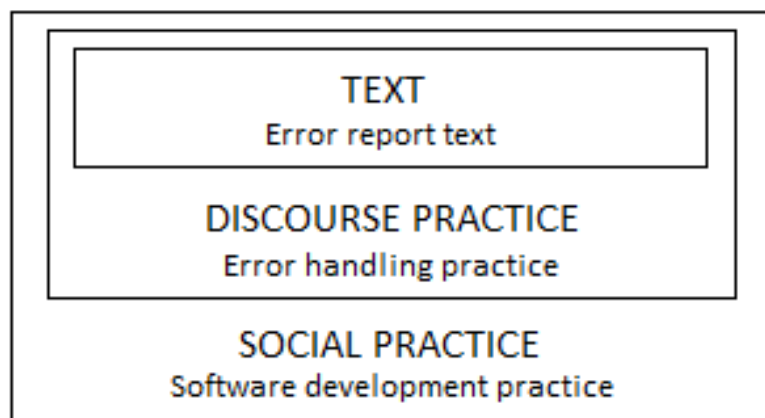
Figure 1. The three facets of social reality in the context of this study.

The criticality relates to the third layer, i.e. the Foucauldian interest in how power operates (Fairclough 2003: 2) Social conditions shape the way in which texts are produced and interpreted (Fairclough 2003: 21). In this sense, discourse embodies ideology and reproduced relations of power (Fairclough

2003: 33). However, discourse also contributes to transforming society (Fairclough 1992: 65). As such, discourse forms a domain where social struggles take place (Foucault 1984, cited in Fairclough 1992: 51).

Discourse does not simply mirror reality. As a social practice, discourse is a mode of action, it brings into being 'situations, objects of knowledge, and the social identities of and relations between people and groups of people' (Fairclough and Wodak 1997: 358). Discourse figures as a part of the social activity that manifests within a practice: part of conducting a job (e.g. being a tester) entails a certain way of using language. In terms of identities, in turn, discourse figures as ways of being (for instance, a company vice president is associated with certain semiotically constituted expectations). Discourse figures in representations. People produce representations of their own practices, but, also, those of others. They *recontextualise* other practices (Bernstein 1990, Chouliaraki & Fairclough 1999, cited in Fairclough 2001: 2) by assuming them into their own practice. (Fairclough 2001: 2.) Representation is, in this sense, a process where practices are socially constructed. They also entail reflexive self-construction (Fairclough 2001: 2).

"Discursive practices may have major ideological effects: that is, they can help produce and reproduce unequal power relations (between… social classes... majorities and minorities) through the ways in which they represent things and position people... Both the ideological import of particular ways of using language and the relations of power that underlie them are often unclear." (Wodak 2003: 187.)

CDA views discourse against the frame of modern power, the latter being mostly cognitive in nature. It is enacted by rhetoric, fact construction, argumentation and other forms of manipulation. In this sense, discourse is management of the mind through text and talk. (van Dijk 1993: 254, 257.) Access to these recourses is usually controlled and institutionalised (van Dijk 1993: 255-256) via subtle, everyday forms of text and talk that appear natural

(van Dijk 1993: 254). To disclose power CDA focuses on the discursive strategies that legitimate control, and naturalize social order (Fairclough, 1985 cited in van Dijk 1993: 254) "to make more visible the opaque aspects of discourse." Wodak 2003: 187).

The critical approach to discourse discloses and challenges social orders, hierarchies of power and practices that are considered legitimate, even natural, but which are, in fact actively legitimized, naturalized, and, further, institutionalized (van Dijk 1993: 254-255). It seeks to disclose the common-sense assumptions, ideologies linked to power, which, are embedded in all forms of language constituting social practice (Fairclough 2001b: 2, 21). As Jokinen, Juhila and Suoninen summarise, discourse analysis studies language use in order to understand how social reality is produced (Jokinen, Juhila and Suoninen 1993, 9-10). This notion constitutes also a central motive for this thesis.

CDA appropriates a variety of concepts from linguistics, social sciences. Some central CDA concepts for this study are *genre*, *intertextuality and assumption*.

Genres are constituted by discourse as part of social activity. They are diverse ways of acting and interacting linguistically. They produce social life, in the semiotic mode. Everyday conversation, news reports, and meetings in various types of organisation are examples of genre. Genres structure texts in certain ways: for instance, news reports have a common structure. (Fairclough 2001: 2 and Fairclough 2003: 17.) Genres help sustain society's institutional structure. For instance, genres of governance recontextualise, i.e. appropriate the elements of a certain social practice within another, and transform it in the process. (Bernstein 1990, Chouliaraki and Fairclough 1999, cited in Fairclough 2003: 32.) Genres can form genre chains, where one transitions from one genre to another. When doing so, they have the potential to enhance *action at a distance* and facilitate the exercise of power. (Fairclough 2003: 30-31.)

According to Fairclough (2003: 39-40), intertextuality refers to the presence of elements of other texts or speech within a text or utterance. Most explicit examples would be direct citations. Less explicit versions would be for example indirect references, such as summaries or rewordings of the originator's utterances or texts. Whereas the former repeats the actual words used, the latter may refer to the text in third person ("she said that"). In the most implicit cases, other texts may become incorporated without separate attribution. An example could be incorporating popular jargon or sayings into one's own utterances, and further, even more unconscious assimilation of what has been heard or read. The latter more implicit cases can, in turn, become and function as assumptions.

Assumptions are an extension of intertextuality. Assumptions can cover presuppositions, logical implications, and implicatures. Texts essentially make assumptions. Assumptions connect one text to others. The difference between intertextuality and assumptions is that the latter are not attributed to certain texts. In some cases utterances that, in fact, propose new refutable claims appear as substantiated assertions. (Fairclough 2003: 40.) For example, "Unresolved quality problems are a major issue" posits the assumption that there are unresolved quality problems. It assumes, further, that the reader knows of and identifies with this assumption.

3. SETUP OF THE PRESENT STUDY

3.1 Aims of the study

Quality construction forms an integral and central part of software development. My aim is to study how networks of actors come together and construct quality in practice, by looking at how anomalies identified during the quality assurance process are dealt with. I will look at how the notion of an anomaly's quality becomes factualised in the first place, and how the strategies of positioning and framing are utilised in the process of quality construction that centres on an anomaly.

In relation to the above-mentioned, my practical aim is to study the discourse and related social practices and efforts that people undertake in the process, and, thus, take a more closer look at the social, rhetorical and argumentative methods and tactics people apply in order to influence others about the courses of action they should take in the social process of quality construction around each anomaly. Since the power to influence and impact the actions of others is also related to the professional roles that participants have in the development community, critical discourse analysis provides a useful approach for deciphering the dynamics at work during an between the application of social power and discursive influence.

3.2 Data

The analysis takes an in-depth look at three error report cases. This material was selected from a random sample of 200 error reports that had been dealt with and closed by the time the sample was taken. One important criteria in narrowing down the selection to the particular three reports was their content. They contained not only descriptions about the reported issue or indications of report status updates, but also explanations for choices made and decisions reached by different parties during the various phases of the report handling, which was essential for the purpose of text analysis. The cases and the

progress of solving the problems postulated in them progressed in time, and thus, had a certain narrative structure, forming intriguing stories around quality construction, which unfolded over time. Limiting the number of error reports to three, in turn, permitted an in-depth analysis of each error report case.

When starting the analysis, it was quite challenging to fathom the fact that material could need multiple readings, even re-readings, and interpretations. The courses and books which promoted the idea of science as something to conduct from an external vantage or window on the world influenced the initial phases of analysing. The ideal that *doing science* progresses in clear steps was strong. (You have to first formulate a hypothesis, then collect your tools, go out and measure the phenomenon, and, finally, return with results that you interpret against a theory.) Letting go and allowing the material *present itself* and *talk to you* did not come about automatically.

However, I noticed that the difference from simply reading and interpreting material in a common-sense way was that the background theories and tools helped elevate certain aspects that would not have otherwise been visible. They helped see, read, interpret and reinterpret the material in new ways. I cannot say there was a logical path to follow, but, a form of analytical cycle of questioning, answering and rethinking. I became a re-interpreter. That is why it IS difficult before the first reading to establish in advance what "is going on" (Goffman 1974: 1).

I originally targeted to have one overall theme to interpret each of the cases against. That sounded systematic. I wanted to have a neat table with neat categorisations. However, in the end, I found certain themes and phenomena to rise out of a certain case more than from others. Though all three error report cases contain all of the three elements, I found certain elements to be more prominent in one versus the other. The final themes are related to what takes place when factualising quality, framing quality, and positioning quality.

The second theme took the longest to discover. It was only after I located the term of *framing* from the newer context of media studies that I considered having located the appropriate frameworks to reflect the material against.

All the cases revolve around a common main unit of analysis. This is how do actors in the organisation in question construct notions of quality and thus quality itself in the context of problem-solving. What strategies and methods do actors draw on in discursive practice to promote these interpretations. In practice, how do actors argument, persuade and justify their standpoints, decisions and actions within the context of collaborative problem-solving.

In order to conceal and protect project names, unit names, and names of people, these have been replaced with the first letter, initials or a description (e.g. If a unit was called Software 2000, this name has been replaced with Unit name). Project numbers have been altered in a way that preserves the relation of one to another, but makes them otherwise unidentifiable, e.g. project numbers 7.2 and 7.3 would be respectively X.2 and X.3. Underlined text indicates a replacement.

3.3 Research questions

The investigation into how quality becomes constructed in the error handling process is formulated around the following research themes and questions. Factualising quality: What kinds of factualisation strategies do actors employ in support of their standpoints, decisions and actions regarding workability? How do they implement these? Positioning quality: How do actors position artefacts, themselves and each other in support of their standpoints, decisions and actions concerning workability? Framing quality: How and what kinds of conception sets do actors construct for and around their supported frames of workability.

3.4 Methodology

3.4.1 Theoretical background. Social constructionist paradigm

All research builds on a certain vision of the world. This vision is, in turn, interpreted into research methodology. (Girod-Séville and Perret 2001: 12-13.) A methodology can be described as an overall, holistic orienting-strategy for generating information about the object of study (Wagner and Berger 1985: 700). It encompasses underlying conceptions about the nature of reality (ontology), the nature and value of knowledge, and concerns about how knowledge is generated (epistemology) (Wagner and Berger 1985: 700-701 and Girod-Séville and Perret 2001: 12-13). It has implications for the role of the researcher and the nature of scientific research in general. It may also frame the significance attributed to research results.

In this study, I assume a moderate social constructionist paradigm. Within the Philosophy of science, social constructionism is often elaborated by contrasting it with the paradigm of positivism, since these (Girod-Séville and Perret 2001: 14) are seen to differ from each other on all methodological levels. This comparison can help clarify the nature of constructivist thought.

At the ontological level, positivism sees reality as an external object, a world which exists independent of the influence of its observer (Girod-Séville and Perret 2001: 15). Constructionism, in turn, depicts reality as a realm constructed in social action. It is the social world. Reality is that which is meaningful in the minds of its observers.[9,10] It manifests intersubjectively shared meanings (Berger and Luckman 1966, cited in Girod-Séville and Perret 2001: 17) thoughts and actions, which are in turn guided by goals (Girod-

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[9] Reality is seen as a social construct dependent on the mind of the observers. The social world, in turn, is not predetermined, but instead, created by thoughts and actions and guided by goals. (Girod-Séville and Perret 2001: 17, 18.)

[10] At the extreme, radical constructivism even denies the existence of any "reality" external to the realm of social action. It sees reality as invented. Moderate constructionists, in turn, bypass this issue. (Girod-Séville and Perret 2001: 16.)

Séville and Perret 2001: 18). It is the implementation of interpretations that actors form in their interactions, in social contexts (Girod-Séville and Perret 2001: 17). Whereas positivism sees reality as a predetermined constant driven by universal laws, constructionism sees reality as contextual. Since meanings may differ from one observer to another, so may social reality: "what is thus "real" to a Tibetan monk, may not be "real" to a businessman." (Berger and Luckman 1966, cited in Girod-Séville and Perret 2001: 17.)

The views about the nature of reality reflect onto the respective assumptions about the nature of knowledge, i.e. the epistemological level, and the role of the researcher in its investigation (Girod-Séville and Perret 2001: 18). Whereas positivist research aims to explain, constructionist research aims to understand. For positivism, knowledge is the sum of causal laws that govern reality and impose themselves on actors. Accordingly, in the positivist framework the role of the researcher is to discover these causal laws and reveal the objective underlying essence of things, the objective truths. (Girod-Séville and Perret 2001: 15, 19.) In the constructionist paradigm the researcher's task is to investigate how meaningful reality is constructed: How is it possible that subjective meanings become perceived as objective factities? How is it possible that human activity produces a world of things? (Berger and Luckman 1966, cited in Girod-Séville and Perret 2001: 17) How do actors construct meaning?

The positivist framework sees the ideal researcher as an external observer of an objective reality (Girod-Séville and Perret 2001: 15-16), the constructionist framework, in turn, depicts the researcher as an interpreter who constructs reality while investigating it (Girod-Séville and Perret 2001: 19). Knowledge feeds back to and shapes our experience as individuals into particular coherent accounts and determines what is counted as evidence (Nelson 1993: 141). The act of knowing constructs reality (Girod-Séville and Perret 2001: 22). Constructionism thus sees knowledge as a process as much as a result (Girod-Séville and Perret 2001: 23).

3.4.2 Qualitative research. Implications for research method and researcher identity

Methodological considerations frame the selection of research approaches and methods. Which of these practices and perspectives are relevant depends upon the questions being asked. However, the questions themselves are influenced by: their context (Nelson et al. 1992, as quoted by Denzin and Lincoln 2005: 4), the available tools, and in a pragmatic sense, the practical constraints regarding what the researcher can do in that particular setting. This study utilises qualitative research practices.

Qualitative research consists of a set of interpretive activities and material practices (Denzin and Lincoln 2005: 3, 6). It involves the collection and study of various empirical materials, such as cases, artefacts and cultural texts, which represent or illustrate routine and problematic moments and meanings in the lives of individuals (Denzin and Lincoln 2005: 3-4). In this study, error reports serve as such material. They enable what Denzin and Lincoln (2005: 12) depict as *rich descriptions* of the social world.

The error reports assume different characteristics and roles. Firstly, each error report figures as an artefact, i.e. historical record or case that discloses past events (Yin 2004: 83). In reference to the case study viewpoint, material can take on one or more roles depending on the object of study. For example, extreme cases provide insight into unusual phenomena, critical cases help confirm or invalidate a conception, paradigm cases perform a revelatory and metaphoric role. Foucault's *Panopticon* is considered to provide an example of the latter by disclosing characteristics of certain social interactions. (Flyvbjerg 2006: 229-233 and Yin 2003: 39-41, 162.) I consider the error reports in this study to also figure as such.[11]

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[11] According to Flyvberg (2006: 232.), it is not always possible to determine in advance whether a case is paradigmatic. There is no standard for the paradigmatic case because it sets the standard. According to Flyvberg, Dreyfus claims Heidegger as saying: "you recognize a

In addition to constituting artefacts or cases for study, it is important to acknowledge the unique role they assumed in the context of their creation and use, where they also served as boundary objects. These are objects that actively link actors and actions (people, objects, and events) across space and time (Scollon 2007: 13-14, 16) performing as routes of communication and mediation between other objects and agents (Scollon 2007: 28). This role is *relived* via the analysis of the stories that the reports manifest.

Regarding the role of the researcher, whereas quantitative researchers traditionally abstract from this world and seldom study it directly, qualitative researchers see the world in action. They take a case-base, emic, position that focuses attention to the specifics of the particular cases at hand. (Denzin and Lincoln 2005: 12.) Accordingly, qualitative researchers may deploy a wide range of interpretive practices in order to gain a better understanding of the subject matter at hand. Each practice, in turn, serves to make the world visible in a different way. (Denzin and Lincoln 2005: 4.)

Denzin and Lincoln define qualitative research as situated activity. It locates the observer in the world. The researcher approaches it with ideas and frameworks (theory, ontology) that specify research questions (epistemology) in specific ways (methodology, analysis). (Denzin and Lincoln 2005: 3, 21.) While aiming to make the world visible, these practices, however, also transform the world turning it into a series of representations, such as descriptions, and memos (Denzin and Lincoln 2005: 3, 21). Qualitative research is, thus, defined by the set of interconnected activities. It acknowledges that behind these activities identified as research process, theory, analysis, ontology, epistemology and methodology, stands the personal biography of the researcher speaking from a particular background, class, gender, culture, and ethnicity. (Denzin and Lincoln 2005: 21.) In my personal case, it is

paragraph case because it shines. You just have to be intuitive." (Dreyfus, 1988, as quoted by Flyvberg 2006: 232.)

important to note the fact that I have accumulated just over 10 years of professional experience in the area being studied. This background provides a privileged insight and ability to understand the social and discursive practices and events that take place. However, there is also a risk that it can also narrow the scope of interpretation in a similar fashion as a set of blinders narrows vision.

3.5 Methods

3.5.1 Rhetoric and argumentation as methods for text analysis

CDA incorporates linguistic analysis as a method to investigate the level of the text. Since this study centres attention on the struggles and negotiations that take place within the realm of error reporting, rhetoric and argumentation provide useful tools to decipher the content of their discursive events.

Rhetoric refers to a long tradition of both the analysis and teaching of persuasion and argumentation, either written or spoken (Haapanen 1996: 23, 45). Originating in the fifth century BC (Billig 1991: 33), its emergence is attributed e.g. to the works of Aristotle and Cicero (Haapanen 1996: 23). Since those times it has undergone phases of appraisal and, during the modern positivist era, even rejection (Palonen and Summa 1996: 7-9).[12]

During this latter phase, just as human progress was reduced to an end result of technological development, so were challenges met with in the realm of human well-being reduced to questions of knowing, issues of truth and fact. Rhetoric in the form of ethical deliberation was considered to hinder and corrupt progress. It was something to be avoided. (Summa 1996: 64-65.) Paired with the ideals of positivism, science as an activity of fact discovery was to take its place (Keränen 1996: 109-111 and Summa 1996: 64-65).

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[12] The rejection of rhetoric in modern times is attributed to the rise of the Cartesianism, which idealised the dialectical (reasoning) over the rhetorical and the rational over the ethical (values) (Summa 1996: 64-65).

During the positivist era, the rhetorical nature of human action, including that of choice and decision-making within the realms of science and politics, and other institutions of power, became obscured (Keränen 1996: 112-113 and Summa 1996: 64-65). Rhetoric, in practice, continued to influence the shaping of the human condition, but now did so unrecognized and unchecked (Billig 1991: 4).

The revival of rhetoric, i.e. *rhetorical turn* took place in the 1950's (Palonen and Summa 1996: 7) originating in the social sciences, more specifically within the field of law. One of the most influential revivalists was Chaïm Perelman who investigated how value judgments gained acceptability in the social world. Value judgments differ from formal arguments in that they cannot be logically verified. However, the legitimacy of the whole of society and its institutions leans on their being generally accepted. (Summa 1996: 62-63.) The relationship between the proponents of value judgments and their audiences inferred more than a transfer of formally true statements from the former to the latter, and positivist approaches to argumentation analysis, such as demonstration (logic) failed to account for this process (Summa 1996: 63- 66).

Though the value of analytic truths in themselves was not denied, their usefulness in explaining socially significant argumentation lead to a dead end (Summa 1996: 66). Perelman concluded from his investigations that the audience was the missing factor which had to be accounted for when dealing with human argumentation (Summa 1996: 67-68). Within the realm of human argumentation the significance of a conclusion depends on how the audience appropriates it (Summa 1996: 70-71). This means that the significance of a fact does not depend on how factual it is but in how it is accepted by the audience (Summa 1996: 66).[13] Since methods of persuasion influence its appropriation, the main ways to legitimate claims in argumentation are, according to Perelman, *rhetorical* rather than *logical* or *valid* (Perelman 1971; 1982; 1986, cited

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[13] Truths and facts are created mutually between the speaker and the audience in discursive action via persuasion, argumentation and agreement on what "truths" are accepted as such (Summa 1996: 70-71).

in Summa 63-64, 70-71). To paraphrase Perelman's quotation of Augustinus: You may teach a fact, but if the target of teaching is getting someone to apply the fact, then the fact needs to be accepted. (Perelman 1982, cited in Summa 1996: 66).

Whereas Perelman revived *the Rhetoric* by disclosing the significance of the human audience as a key factor in the success of argumentation, two other counterparts, Kenneth Burke and Stephen Toulmin, influenced the revival in different ways. Burke took the human element a step further by elaborating the significance rhetoric and persuasion had in social competition, organisation and power-play (Summa 1996: 52, 55-57). Burke targeted to *demystify* the rhetorical strategies of the *genius, and crafty* (Summa 1996: 59-62), and reveal the dual ability of argumentation to draw on the nexus of knowing and wanting (Summa 1996: 64-65). Persuasion relies on the ability to increase proximity between people through identification or distance from them through distinction (Summa 1996: 58-59). The effect of rhetoric is not dependent on how convincing, skilful or *logical* argumentation is, but, instead, relies on the application of a holistic arsenal of rhetorical methods such as repetition, technically efficient forms of media, etc. (Burke 1969. cited in Summa 1996: 59).

Language use is ultimately a human phenomenon, the basis for sharing our interpretations with others (Burke 1945; 1969, as quoted by Summa 1996: 55). This also entails some common human ground enabling joint understanding. Communication is a social phenomenon, the meeting of souls. (Perelman 1971, as quoted by Summa 1996: 66.)

The third revivalist, Stephen Toulmin, focused on analysing the argumentative structures and procedures enacted in human argumentation. He was interested in presenting the structures of human reasoning and argumentation as it occurred in reality. For this purpose, he introduced informal and applied logic as a tool. (Summa 1996: 73-75.)

According to Toulmin, the deductive, i.e. demonstrative form of reasoning, propagated as the valid from of argumentation, is based, on the fallacy of applying the model of analytical syllogism as the model for all reasoning. He showed that critical and scientific thought is based in practice on many different forms of reasoning. For example, usage of modality and probability are common in human argumentation. (Toulmin 1958, cited in Summa 1996: 76-77.) Similarly as Perelman, Toulmin also separates demonstration and actual real life argumentation from each other (Summa 1996: 76).

3.5.1.1 Aristotelian rhetoric

Thus, we come back full circle to linking rhetoric with argumentation, and further, the realms of the rhetorical with that of the dialectical, as was originally postulated by Aristotle. This study assumes takes this linkage as a starting point for analysing the textual material.

All texts are, in some sense, rhetorical, i.e. strategic presentations of ideas. (Edwards, Nicoll, Soloman, Usher 2004: 174). In an Aristotelian sense, rhetoric is the discovery of available means of persuasion in different cases (Freese 1926: xxxii, 13). At a general level, rhetorical analysis examines the way we attempt to persuade or influence others in gestural or textual practices (Edwards et al. 2004: 13). It, however, also, in practices, examines how truths and knowledge are constructed (Edwards et al. 2004: 7), how people manage to arrive at understanding (Potter 1996, as quoted by Edwards et al. 2004: 3), and the ways in which the audience is positioned or mobilized through the rhetorical act (Edwards et al. 2004: 18). In other words, it helps us understand how we use language and how language, in essence, works for us.

Rhetoric is the power to discover the means of persuasion on almost any subject presented to us; and that is why we say that it is not concerned with any special or definite class of things (Freese 1926: 13, 15). Rhetorical analysis can comprise analysis of the entirety of a text or focus on its argumentative

constituents (argumentation analysis).

The simplest form of rhetorical analysis is using what is called the rhetorical triangle. Developed by James Kinneavy, the triangle links Aristotle's rhetorical elements of ethos, pathos, and logos with the participants using them. Ethos focuses on the author, pathos involves the audience and logos implies references to the world or reality that are shared by the author and the audience. (Killingsworth 2005: 26.) The model has been criticised for lacking e.g. connections to context (e.g. cultural obstacles to solve) (e.g. Killingsworth 2005: 28). However, it does highlight the positions and alignments of participants in the communicative acts. A simplified version of the original triangle is located below.

Author   Audience

TEXT

Reality
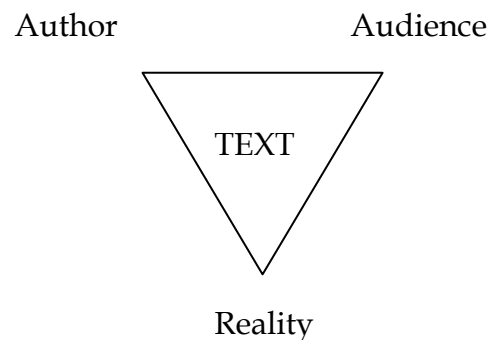
Figure 2. Adaptation of Kinneavy's rhetoric triangle.

Aristotle distinguished between three main rhetorical contexts, each alluding to its respective primary rhetorical purpose and audience, and drawing on specific means or persuasion: the forensic context deals with past matters of guilt or innocence, its primary style is that of attack or defence, and means comprise those of law, oath and witnesses. The political i.e. deliberative context deals with matters of future policy, advising for or against certain action and drawing on the arguments of their resulting harm or good, epideictic or ceremonial oratory deals with present issues eliciting and

utilizing methods of either praise or blame. (Freese 1926: xxxiii-xxxvi.)

Aristotle presented rhetoric as the counterpart of dialectic. Both were considered to function as generally applicable methods to utilize in argumentation, i.e. not being limited to a definite science (Freese 1926: 3). However, whereas dialectic builds upon premises of certainty and targets to establish logically true conclusions, rhetoric builds upon premises of probability, and targets to achieve pragmatically and emotionally (e.g. morally) acceptable solutions (Freese 1926: 15, 474).

Though rhetoric encompasses a wide range of concepts and strategies (e.g. metaphor, principles of delivery), the main framework of persuasion comprises of three modes of proof or *artistic appeal*: logos, ethos and pathos. Logos appeals to evidence that is either intrinsic to an argument, such as common sense or logic (e.g. enthymeme i.e. deduction from global principle to specific truth, induction, i.e. deriving global truths from a specific example) or extrinsic to it, such as observational or empirical data in the form of testimonies and statistics, etc. Ethos appeals to trust, and accordingly, proof is invested in the reputation or credibility of e.g. the arguer. In practice this can relate to his or her experience or expertise in the matter, or authority. Pathos draws on emotion eliciting feelings such as sympathy from the audience. (Freese 1926: xxxii and Charney et al. 2006: 67, 75, 78.) These modes of proof are further implemented through reasoning and knowledge of passions (Freese 1926: xxxii). These, in turn, take the form of arguments (and fallacies), i.e. the concrete acts (speech acts and texts) of persuasion.

4. ANALYSIS

4.1 Quality assurance in the software development organisation being studied

Finding the errors

In the organisation investigated in this study, software testing constituted the central practice of the software development process during which the quality of the created software was assessed. Another name for this phase was quality assurance. In the most basic sense, testing meant investigating whether the software implementation, both its content and functionality, met the requirements and expectations it was designed and intended to fulfil. In a SCOT sense, quality can be thought of in terms of the level of workability that an artefact reached.

Software implementation refers here to the actual software creation process, comprising the practices of code creation and localisation. As a process, testing complemented implementation, and could take place alongside the main phase of creating software, constituting either an integral activity of it, or a separate, subsequent phase, depending on the adopted ways of working and applied model of development. Design, implementation and testing can be illustrated as a triangle of positions related to, and approaches towards, the development of software, the software itself, and each other.
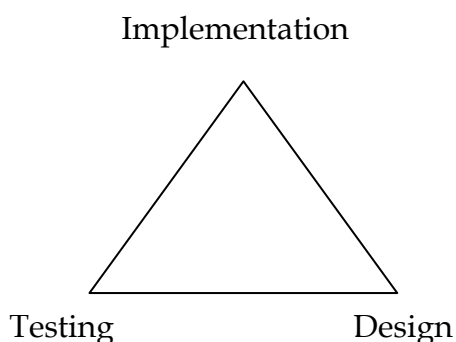
Figure 3. Relation of development roles in software development process.

In the process of error report handling, discussions about issues with quality revolved around three central questions. The first related directly to the theme of workability: "Did the reported error pose a problem for the use of the software or not?" The second question related to estimating the value of an acknowledged workability issue, i.e. deliberating on whether the problem needed to be fixed or not. The third theme related to questions about how the acknowledged problem should be solved.

Within the software development framework in question, issues with workability were in principle separated into matters of usability versus correctness. Quality assurance and error reporting were, as the word *error* infers, associated strictly with the latter, i.e. problems with correctness. In practice, expectations for correctness were in some cases easy, and in others, more difficult to define and interpret. When the conception of correctness was grounded on certain co-produced or pre-defined design documents, guidelines and technical standards, issues with it were relatively clear to all involved parties. For some implementation issues, there, however, were not always standards or pre-defined solutions available or they may have been unclear or open to interpretation. Classifying a problem as a usability issue rather than one related to correctness usually meant it was purged from the error handling process, and in general from any other form of high-priority action. However, as the first analysis that centres on factualisation strategies during error handling will show, sometimes even correctly implemented software was not considered to work, and, thus, problems which by definition were originally issues with usability, rather than errors became treated, in practice, as errors.

Though implementation problems, by definition, were very concrete in the sense that they could at worst result in bad user experience, each problem manifested itself on a continuum of good and bad quality as an individual incident. Its place on this continuum depended on what *priority* and *severity* it was assigned. Two main questions concerning the error itself influenced this

place: how serious was the problem from a technical point of view (e.g. Did the application need to be restarted?) and what was the estimated user impact (e.g. Would the user notice the problem? Would it impair use of the feature?). However, also external questions also came into play, for example, how much time was there left to, on the one hand, resolve the problem, versus, on the other hand, carry out other work? Ultimately, thus, three factors became interrelated and impacted the errors place: quality, time and resources, and these were sometimes in conflict with each other. For instance, if project deadline were approaching, fixing the error could have been thought to cause more problems, risking the overall software quality readiness or maturity, in addition to project schedules.

The actions for resolving each alleged error were determined against the above-mentioned evaluations. Good and bad were then not in practice absolute or related to purely objective factors, regardless of whether each issue alone would have been either true (an error) or false (not an error). Instead, they were relational. In the end quality became a question of acceptability. The continuum of good and bad quality was interpreted into one of acceptability versus unacceptability, i.e. what was the *sufficient* versus *necessary* level of workability?

Though immense effort was put into internal deliberations over quality, the ultimate measure of successful quality and workability would be measured by customer satisfaction, in practice, how this translated into purchasing decisions: Would the customer acquire new products in the future?

As indicated above, quality was not always an *on/off–issue*. Even with acknowledged problems, multiple factors came into play when deciding how to deal with them. Quality was an outcome of, negotiations, debates, related social struggles and collaborations, and ultimately decisions which influenced the direction of the software. In this process, discourse, rhetoric and argumentation had a central role.

Importance of the processes

Because of the huge amount of reported problems that could amount to thousands within any given software development project, to help tackle this evaluation and decision-making process there were guidelines and so-called *processes*. They targeted to help analyse and classify the error against the expectations of quality. Another reason related to the fact that each error and the decision on its fate could impact the work of many people, and these people were often dispersed and had different professional backgrounds. Thus guidelines to help overcome distances, and interpretive differences were necessary.

Error reports

The medium for specifying an alleged problem located in software was a so-called error report. These were electronic documents containing a description of the problem, which, to apply Forensic metaphors, *presented the case* and the *evidence*. As its investigation progressed, different stakeholders, such as software developers deliberated over and *cross-examined* the case, adding respective comments and solution proposals to the report. Decisions on how to proceed and act in the case were also written there. Thus, the error report formed a *case file* or record on the matter and inscribed the history of how it was being dealt with. Error reports were created mainly by software testers. However, anyone in the research and development, i.e. R&D community using software under the focus of development was allowed to create an error report or have one entered on their behalf.

Many functions of the error report

At the very basic level, an individual error report served to document an alleged error located during testing. It then helped stakeholders follow-up the progress of the error handling process. At this level, they served as a core source and reference for discussing, dealing with, and managing the alleged error between various stakeholders.

However, error reports were utilised in other ways too. Their function varied laterally from stakeholder to another. For example, error reports were a source of learning for other testers. Each error report can be considered to have formed a link in, what Fairclough calls, a genre chain (Fairclough 2003: 31) Compressed into a cluster represented by graphs and numbers, the reports formed chains of knowledge against which the quality of components was evaluated, predictions on the project's schedules made, and various related trends depicted. Their significance also varied in a vertical sense. The functions of knowledge were hierarchised, and accordingly the meaning and form reports assumed at different levels transformed: reports could be used to measure and evaluate the performance of software teams. For instance, rewarding systems could assume certain targets concerning error report amounts below which teams aimed. Testing effectivity in some teams was periodically measured by evaluating how many of the errors that should have been found during certain testing phases leaked to the customer. In this sense, the reports functioned, among others, as specific apparatuses and genres of governance that recontextualised elements of one social practice within another, and transformed them accordingly. (Jessop 1998, forthcoming , cited in Fairclough 2003: 217.)

As the life of the error report was sliced into weekly or monthly measurement points, these points could loop back to influence the progression of the error. Sanctions attached to these measurement points guided activities around the error reports. In some situations, these sanctions emphasised the oppositional nature of the different roles in the development triangle. In some cases, the triangle for ensuring quality become a triangle of conflict between different positions rather than that of complementation.

As the error stories were compressed at each hierarchical step, so was comprehension. Microprocesses were zoomed out reducing visibility into the complex reality of the software development process. Compression also introduced a veil of simplicity that obscured this reality.

Error database

Error reports were created, edited, updated and stored in an error database to which access was given by default to all internal and, to some extent, external members of the R&D community, such as external suppliers. As a form of globally accessible information technology (Fairchild 2004: 114), the database permitted the gathering, integration, analysis and dissemination of vast amounts of information, globally enabling different parties to link across, time, distance, local culture and space. In practice, the database functioned as non-realtime *groupware* (Fairchild 2004: 46), i.e. a collaborative system, which allowed users to interact and share data around the error. Error handling involved also other forms of interaction and communication, such as emails and meetings etc., but in many cases, and between some interfaces, the error database functioned as the sole nexus of interaction and communication. How far it served as a complementary or isolated communication form varied between people and teams.

Just as error reports themselves had multiple functions, so had the error database. It functioned as a global and centralised archive or *tracking database* (Fairchild 2004: 71) for logging data, decisions and related significant actions. It was a journal of activities inscribed around the errors. In relation to the function of learning, the error database performed as an *information repository* (Fairchild 2004: 76-77) archiving otherwise tacit knowledge for future use. It was, also, an *argumentation system* (Fairchild 2004: 51) providing a space for the presentation and discovery of a multitude of opinions. Finally, the error database was a tool for *multiparticipant decision-making* (Fairchild 2004: 65), enabling participation independent of place and time.

Virtual community

Though some users may have formed real-life co-located, structured, collaborative teams or "communities" in the traditional sense (in reference to

characterisations of communities by Fairchild 2004: 99[14]), the majority of users were globally and organisationally dispersed. Software testers were in some cases located in software development teams, however, for some expertise areas, such as those focusing on the testing of specific scopes or features throughout the software or software-hardware combinations, such as performance or language features, they mostly were not. Additionally, error managers may have covered multiple teams and were thus not necessarily co-located. Developers or translators (localisers), in turn, often worked on multiple projects at a time.

The error database provided a framework that joined people into a loose virtual community similar to that of an Internet forum, in the sense that interactions revolved around the active errors or themes at hand. The database formed a *discourse community*, which to apply Porter's (1986: 38-39) definition consisted of a group of individuals who were bound by common goals. They, further, communicated using a shared repertoire, enacted via regulated discourse and channelled through joint mechanisms of intercommunication. As a community, it shared assumptions about what types of objects were appropriate for examination and discussion, and what functions could be performed on those objects, what constituted *evidence* and *validity*, and what formal conventions were followed.

However, in relation to error handling, the *virtual* community that formed around an alleged error case was momentary. In general, as Fairchild describes (Fairchild 2004: 100-101), "Virtual teams are groups of people that work together but are physically apart. Their activities are time-bound – they come together to accomplish a specific task and when their objective is met, they disband, with members joining other newly forming project teams." The lifespan of virtual teams depends on the needs of specific business deliverables

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[14] According to Kaplan and Bartlett (2002, cited in Fairchild 2004: 99), a community can be small or large, co-located or online. Their members interact together over time, are held together by a common purpose, possess distinct roles, rely on trust as the basis of their interactions, and share a sense of history.

(Fairchild 2004: 101). From a process point of view, being able to quickly and efficiently assemble, launch, build, manage, and reallocate virtual team resources is critical for organisational success (Kaplan and Bartlett, 2002, as quoted by Fairchild 2004: 101).

Actualised processes

The notion of *process* used in the context of information technology originates from the realm of machine systems, such as automation (Convey 1995: 19-20). Emerging from the backdrop of mechanical rationalism (Convey 1995: 18-22), process descriptions and diagrams describe the desired flow of action to be followed in order to reach a certain goal (Convey 1995: 21-22). When applied to human action, they target to help actors navigate through the process, they, however, also constrain human action and limit available choices. In practice, the ways in which processes are actualised depends on the social realm and the individuals within them. In the context of the error database, In the analyses, I will present how the codes of human behaviour, including rhetoric and argumentation, not only those of mechanical rationality, came into play.

Process description

The error handling process was divided into four main phases: analysis, planning, correcting and verification. The main route (green arrows leading from the status of *Detected* through *To be evaluated* and *In progress* to *Released* and *Verified*, and finally *Closed*) roughly coincided with the moments of translation: acknowledgement of a problem lead to escalation in action, i.e. mobilisation, which, in turn, diminished as stabilisation and closure was reached.
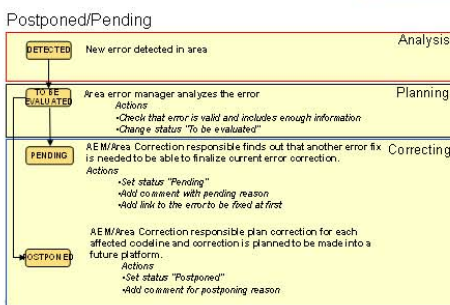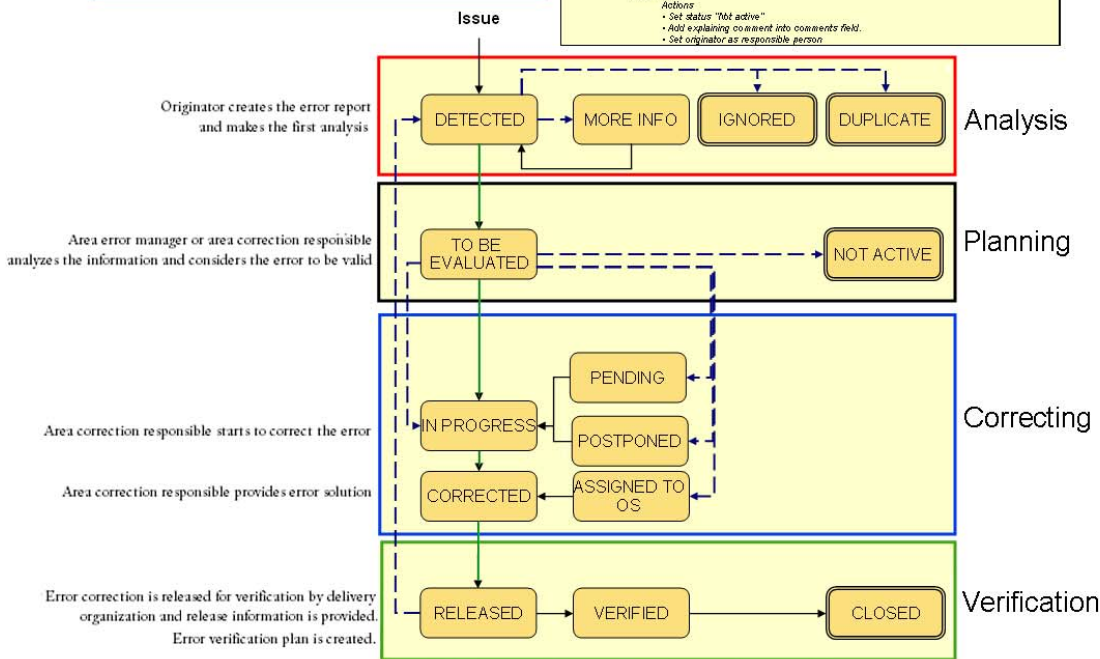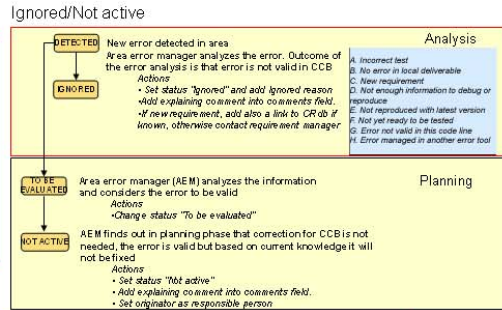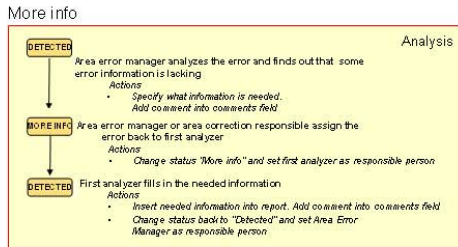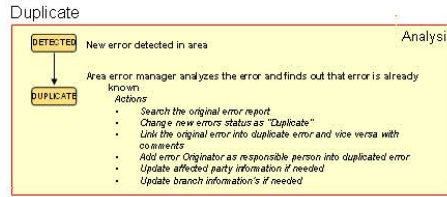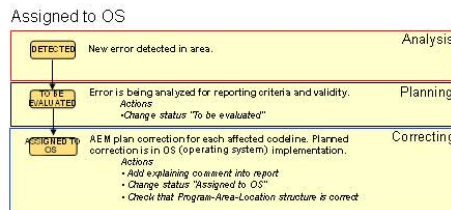
Figure 4. Error report handling process description, adapted from the official error process description (Internal 8: 2008).

As a result of each translation phase (or link in the chain of discursive events), the error report was assigned to certain statuses that reflected the action taken on the issue. When an error report was created it went automatically to *Detected* status. If the reported error was *Evaluated*, and if it was still considered valid, it moved down the main route leading it to being *Corrected* and then *Closed*. There were, however, alternate routes to reaching closure and the termination of action. The most generally used was *Ignored*. This status was assigned to errors, which had, for example, *fixed themselves* (were not later reproducible anymore), or problems that were not, in the end, considered errors. *Duplicate* status was assigned if the error reported was considered identical to some previously reported problem. *Not active* and *Postponed* statuses were used for issues which were acknowledged as errors but whose solving or fixing was either deferred to a later time or simply rejected. The process description depicts decisions of closure as final.

Making choices between alternate options of action or reaction inferred processes of evaluation and decision-making. In all of these phases and crossroads of choice-making language came into play, either as an expression or a medium of action.

The discourse revolved around four main questions: "What is the problem?", "Is there a problem?", "What is the value or impact of the problem?" "What is the solution to the problem?" The analysis looks at the discursive action that took place in relation to these questions.

Roles

Once you entered the realm of error handling, you assumed certain responsibilities and roles that were assigned to you through the report, and were given tasks to take care of. Whereas the role that initiated the error handling process is, in this study, called originator, other roles comprise error manager, software developer, localiser or localisation coordinator. Originator, thus, refers to the general reporter of a software problem. The roles in the

frame of error handling corresponded to process-based positions of power regarding decision-making and action. This power is depicted in the process diagram via, e.g. rights to closing or assigning error reports further.

These error handling related roles were not all and always necessarily related to roles in the organisation outside the context of the error handling process. Whereas the initiating role called here originator, usually was held by software testers, any person who had located an issue had the responsibility and possibility to report it, and thus become the originator. In addition, the role of error manager was sometimes appropriated by a team manager, or a software developer, or a localiser, rarely, however, a tester.

Most of the time, the originator was, in practice, also the one who had located the issue, and often, as in the cases analysed in this study, a tester. She or he also participated to varying extents in the problem's investigation. The error manager assigned the error report to different statuses and locations (e.g. development teams) depending on the decisions made about how to proceed with the error report. In practice, error managers sometimes also participated in the problem solving. However, their *managerial* role in the real world, was usually limited to that of facilitating other decision-making parties. An extremely important role of an error manager was to perform as a gateway between different parties.

4.2 Factualisation strategies

Central is not only what we speak but also who speaks, and what the outcome of this speech act is (McGrath 2003: 486).

According to Foucault, the production and application of discourse is interlinked with the production and application of power and knowledge. In a circular relation, power produces knowledge through discourse and knowledge when applied through discourse produces power, serving to either enable or constrain action. (Foucault 1980: 131.) Power can function as a method of repression, but in some cases it also "traverses and produces things, it induces pleasure, forms knowledge, produces discourse" (Foucault 1980: 119).

Hall states on the basis of Foucault (1977) that the power of knowledge resides in its value as being *true*. However, knowledge need not be fundamentally or scientifically true to assume the status of *true*. Instead, when linked to power, knowledge can appropriate the authority of *the truth* and *make itself true.* (Hall 1997: 49.) "All knowledge, once applied in the real world, has thus real *effects*, and 'becomes true'." (Hall 1997: 49).

Interpretations of the truth are formed in social discourse. What is considered true is what is presumed, applied and reproduced as true by a given community. Truth is a discursive formation which along with other truths sustains a régime of truth. (Hall 2001: 76 and Fairclough 1992: 49.) To quote Foucault: "Each society has its régime of truth… types of discourse it accepts and makes function as true." (Foucault 1980: 131). The significance of a truth is not grounded in it being a universal, scientific truth, but, rather, in the acceptance of it being deemed true (Foucault, 1980: 131-132). The "general politics of truth" (Foucault 1980: 131) comprise the mechanisms and instances, e.g. procedures, "which enable one to distinguish true and false statements, the means by which each is sanctioned, the techniques and procedures

accorded value in the acquisition of truth; the status of those who are charged with saying what counts as true." (Foucault, 1980: 131).

Discourse, power and knowledge function through three facets: "a community in which the discourse emerges, institutions with knowledge and authority which delimit the discourse, and grids of intelligibility which enable particular practices to be related to each other in a specific type of discourse" (McGrath 2003: 486). Régimes of truth are then put into practice via a variety of methods and techniques constituting regimes of practice (Mitchell 1994: 203). These may be procedures or, so-called, games of truth. Truth is inseparable from the procedure, the processes and methods, which establishes it. (Deleuze: 1988: 63.) The other way round, in order to understand how truth is created, it is important to understand the procedure via which it became true.

Made up of rules and procedures, discourses construct and legitimate the way actors see things and talk about them. Discourses validate certain statements and communicational practices while invalidating others. (Casey 1995, as quoted by Rose and Krœmmergaard 2003: 442.) Ultimately, discourse connects to apparatuses of power and knowledge, i.e. "strategies of relations of forces supporting, and supported by, types of knowledge" (Foucault 1980: 196). The elements of apparatuses can be institutions, regulations, laws, administrative measures, moralities, etc. (Foucault 1980: 194).

Organizations are discourse communities that share socially constructed systems of meaning (Barley 1983, as quoted by Martin 1992: 51). Rules and procedures are used to implement power and control and provide a stamp of approval on what is to be held as true (Martin 1992: 52, 61). Due to the different techniques and discursive practices that power has encapsulated the individual in, individuals can be seen as intermediaries and instruments of power (Deleuze 1998; Hoy 1986; Sheridan 1980; as quoted by Edenius 2003: 75). However, since discourses are located in practice, they are not necessarily simply recreated as such.

Discourses not only reproduce but also transform power relations. In this sense, they are, therefore, political processes. (Phillips and Hardy 1997, citied in Hearn and Michelson 2006: 289.) Though discursive knowledge, assuming the form of truth, may construct and constrain how members act, the constitutive impact of this discursive practice depends on how it interacts with the already preconstituted reality including the interpretations of preconstituted social subjects and the balance of power between those in struggle. Power may reproduce or it may change the domain of knowledge and knowledge may reproduce or may change the power relations. (Fairclough 1992: 50-51, 60-61.)

Disrupting everyday discourses, pointing out ruptures, absences, and breaks, reveal contradictions in the prevailing symbolic order (Martin 1992: 160). Language has great significance in producing and sustaining power relations. However, it also has a great potential for changing them. (Fairclough 1981 and Fowler 1985, cited in Jokinen 1993: 189.)

Via the error handling process, a particular set of procedures, practices and processes are created within the realm of software development to construct a particular *régime of truth* about quality. Applying Foucault's (1978) ideas regarding practices of the self as presented by Dean (1994: 203), these conditions make possible certain forms of knowledge about quality and allow quality to be a domain of intervention. Located in the apparatus, practices and discourse, they constitute quality as an object of knowledge, and domain of governmentality.

Knowledge is structured through systems of protocols and procedures (Foucault 1980: 102). In the techno-scientific realm, the latter outline a framework of steps, which stabilise knowledge and lead to it being solidified as a fact (Latour and Woolgar 1986: 106). In the context of software development these régimes of practices serve to also question, analyse and dissect workability, and evaluate its value. Quality is here the outcome of the

respective techno-engineering discourse. Issues with workability are, further embodied in error reports metaphorised as errors, incidents, failures, faults, or more animately, bugs.

Error reporting is a process which re-opens the closed black-box of already stabilised technology. An error report figures as a statement about quality opening the software up for interpretation. The process of fact construction serves to create and inscribe new truths in relation to the alleged errors. In the error handling process, a decision on whether an artefact is to be treated as an anomaly to be actioned or not either solidifies or dissolves the factuality of the premises that originally constructed the basis for the artefact's acceptance as a workable object.

The acts of decision-making are grounded on various types of input and the evaluations made on the basis of this input. The input is used to evaluate whether a reported problem is serious or not, and most importantly, whether or not it actually constitutes an error. Each decision reached leads to either embarking on further action or refraining from it, and as an effect, impacts the shaping of quality.

In the context of error report handling, closure is achieved through decision-making. Decisions mark closure, at least temporarily. Closure solidifies and inscribes facts, which, in turn, constitute truths about quality, until and unless they are questioned separately.

Latour and Woolgar (1986: 82 106) conclude that a fact is a statement that loses all modality. Once a fact is established, or re-established, the social factors that were involved in its construction disappear. When the black-box on technology has been closed, facts appear unconstructed by anyone. (1986: 23, 240.)

The methods actors employ in this process can be described as, what Juhila (1993) calls, factualisation strategies. Abiding the definition of Kirsi Juhila (1993: 152), a factualisation strategy is a form of persuasion, via which the factual value of the related piece of information becomes so great that the version in question appears the only right one and self-evident. Ultimately, the resulting stabilised facts constitute facts about the software's quality as projected to and relied on by customers. In order to investigate how artefacts become stabilised, I will look at how strategies of factualisation are employed during this process.

Whereas Juhila investigates how statements that are presented as facts by those who assert them serve to factualise certain conceptions about things and people, I will look at the rhetorical and argumentative methods agents draw on when attempting to construct, propose and solidify something as a fact (due to the nature of the material representing a process where facts are in effect being constructed in a context of social negotiation about them). This leads to focusing on what Latour and Woolgar characterise as the micro-processes (Latour and Woolgar 1986: 153-4) that participants apply in fact-construction.

Here are the general factualisation strategies actors utilise according to the framework of Juhila (1993): The first is the factualisation strategy of the self-observation (Juhila 1993: 158). In this strategy the speaker draws upon events and circumstances that the speaker claims to have seen or heard. Persuasiveness is based on the fact that the audience cannot doubt the truth of the presented information as the latter were not there to experience it. The speaker, however, acts as if he had been present in the event, but not as an active participant, since involving oneself in the event being described appears to reduce the factual value of the information (Juhlia 1993: 160). In this strategy, descriptive details strengthen the impression of authenticity (Atkinson 1990: 135; Edwards and Potter 1992: 123 and 161, cited in Juhila 1993: 158).

In the second factualisation strategy of no alternatives (Juhila 1993: 163), the speaker convinces the audience that there is only one way to solve issues at hand (Juhila 1993: 163) even though the existence of other options may be acknowledged (Juhila 1993: 167).

The third factualisation strategy of quantification (Juhila 1993: 168) builds on the quantification of events and circumstances. Especially precise numbers increase the truth value of information, but even approximate quantification can increase the persuasiveness of argumentation. Other attributes than numbers can be used as methods for quantification. These include, for example, quantities, portions and relationships. These can be represented by words such as a lot, quite, all, marginally. In this paper, I am also considering other extrinsic methods, such as empirical evidence, and logical inferences that the speaker uses to corner the issue at hand to comprise methods of quantification.

The fourth factualisation strategy of social norms draws on joint social norms. Norms are principles that build upon established conceptions and habits that are difficult to refute (Juhila 1993: 172). When they appear to be supported by the majority of people, they gain the notion of being self-evident principles (Juhila 1993 172-173).

In the fifth, and final factualisation strategy of expertise, persuasion builds on specialist knowledge. This can be, for example, administrative, professional or scientific in nature. This strategy covers not only external expertise, but also personal-expertise, which can in some cases approximate the strategy of self-observation. (Juhila 1993: 178.)

It will be interesting to see, on the one hand, how facts and truths are produced at the microprocessual level of error reporting and handling in the techno-engineering discourse context, and, on the other hand, how the former are, further, utilised in, and towards achieving, different phases of translation within the process of quality construction.

4.3 Framing strategies

The terms frame and framing are attributed a variety of meanings depending on the approach in question. Cognitive psychology associates frames with deeper unconscious mental constructs, such as underlying knowledge structures and knowledge frames, plans and expectations which shape conscious experience (Bransford 1979; Helson 1964; Mandler 1975a; Miller, Callanter, and Pribram 1960; Minsky 1975; Piaget 1952 and Rumelhar and Norman 1977, as quoted by Baars 1988: 139). In this approach, frames refer, similar to *schemes* (Tannen and Wallat 1993, citied in Ensink 2003: 65) to conceptual structures that are invoked by words and utterances (Lee 1997, cited in Ensink 2003: 65).

In anthropological and sociological perspectives, the interactional nature of frames is emphasised (Tannen and Wallat 1993, cited in Ensink 2003: 65). Frames provide shared frameworks against which to interpret behaviour (Ensink 2003: 65-66). According to the Sociologist Goffman, a frame refers to implicit "definitions of a situation... built up in accordance with the principles of organization which govern events -at least social ones- and our subjective involvement in them." (Goffman 1974: 10-11)[15]. Analyzing frames, in turn, means examining the organization of experience (Goffman 1974: 11).

Teun A. van Dijk and Paolo Donati build on this perspective introducing the concept of discursive structural frames, which people employ to organise topics of discussion, and higher level frames, which people use to make sense of the information they encounter in the world. The study of frames in this approach provides an insight into how people form an understanding of issues that arise in public debates. (Fisher: 1997.)

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[15] According to Berger (in Goffman 1974: xiii), situations are what other analysts refer to as settings, backgrounds or contexts where interaction occurs.

Communication studies have, in turn, used the term frame to refer to the process during which certain aspects of a perceived reality are selected and made salient in a communicating text. According to Entman (1993: 391) communication texts are considered tools for exerting power by influencing human consciousness, especially in benefit of the goals or agendas set by the one promoting them. It is this version of the frame concepts that is relevant for this study.

According to Entman (1993: 392), frames define problems, diagnose causes, make moral judgments, evaluate the causes and suggest solutions. Some sentences may perform multiple framing functions, whereas others none at all. Some frames may, in turn, perform only some of the functions. Each frame is linked with at least the following four roles or locations: the communicator, the text, the receiver, and the culture. Communicators make framing judgments when deciding what to say. They implement schemata (also themselves frames) that relate to their belief systems.

Texts contain frames. These are embodied by either the presence or absence of keywords, stock phrases, stereotyped images, sources of information and clusters of facts or judgments. The schemata that guide a receiver's thinking may or may not, however, reflect the frames in the text and the framing intention of the communicator. (Entman 1993: 392.)

Culture is considered a set of common frames that are exhibited in the discourse and thinking of most people in a social group. In all the four locations framing implies similar functions: selecting and highlighting certain elements, and using these elements to construct an argument about problems, their causation, evaluation, and solutions. (Entman 1993: 392.)

By making certain information salient, texts enhance its meaningfulness, and make it noticeable and memorable (Entman 1993: 392). Rhetoric can be considered as a central strategy in this process and methods used can be for

example repetition or associating information with familiar cultural symbols. However, salience of an idea can also increase if the idea comports with the existing schemata in the receiver's belief systems. For existence, stereotypes can be considered mentally stored clusters of ideas that guide the way information is processed. (Entman 1993: 392.)

Whereas Goffman's version of the concept of frame refers to a more personal and non-intentional construct, Entman's version brings a more public, political and goal-oriented perspective to it. This is at least due to the different starting points of the perspectives. Whereas for Goffman the study of framing relates to the study of representation and meaning (Fisher: 1997), for Entman, the analysis of frames investigates how the transfer of information (such as a news report) exerts influence over human consciousness (Entman 1993: 391). The political nature of framing is highlighted when linking it to the exercise of power and dominance. For instance, by controlling how issues are framed, political elites can control public opinion. (Zaller 1992, cited in Entman 1993: 396.)[16]

When applying it, further, to the SCOT notion of technological frame, Entman's concept of frame provides it a more power-oriented interpretation which Klein and Kleinman (2002: 30) have criticized it to lack. It brings into focus the strategies people utilise to gain hegemony for one frame, interpretation, or discourse, over another.

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[16] or example, if an issue is framed in three alternate ways, and the first generates 40 percent of support, the second 50 percent and the third 60 percent, approving the option with 60 percent support is not axiomatically the most democratic response (Riker 1986, cited in Entman 1993: 396).

4.4 Positioning strategies

Positioning theory brings together social psychology and the analysis of discursive practices for investigating how the social self of participants becomes constructed within collective processes. It centres on the interaction that takes place during related communicative arrangements (Harré and Moghaddam 2003: 3-6 AND Bora and Hausendorf 2006: 37.)

A position can be defined as a loose cluster of rights and duties that enable and constrain action. They outline the repertoire of possible actions within a certain setting, and, hence, in practice influence what participants can say and do. (Harré and Moghaddam 2003: 5.)

Social positioning, in turn, refers to the dynamic assumption and attribution of situational identities, rights and duties, during certain, mainly social, activity (Harré and Moghaddam 2003: 3-5 and Bora and Hausendorf 2006: 36). Social positioning relates to the manner in which images of self and others are set in relation to each other during an episode of communication (Bora and Hausendorf 2006: 26). Positioning takes place in interaction with other people and, also, through intrapersonal dialogue, within the self (Taylor, Bougie, and Caouette 2003: 205-206) and constitutes an interactive achievement in the social arena (Bora and Hausendorf 2006: 26). A position implicitly defines the repertoire of socially possible actions available for a given person. (Harré and Moghaddam 2003: 5) and can constrain or empower actors (Harré and Moghaddam 2003: 7).

Positions are discursively enacted through processes of social categorisation. Social categories are mental representations, such as stereotypes and beliefs, which are expressed and played out by participants in discourse, and clarify what is going on. In this sense, positioning relates not only to mental but also communicative representations. These can, in turn, be traced back to the very surface level of discourse as what participants make noticeable. (Bora and

Hausendorf 2006: 37.) Discursive practices, in turn, figure as the ways in which agents are positioned, as well as in the ways conceptions of identity are socially created (Bora and Hausendorf 2006: 37).

The speakers' social positions, more or less, correlate with the discourse types. available for them. As Bora and Hausendorf summarise: "As far as these social positions are manifested in the speakers' concrete contributions, the participation process can be considered as a process of *social positioning*." (Bora and Hausendorf 2006: 35.) Communication actualises, re-creates and modifies pre-structured participation concepts that procedural framing gives rise. It also manifests the struggle over these concepts through different social positions and their related discourses. (Bora and Hausendorf 2006: 26.) The focus on discursive practices acknowledges the dynamic aspects of positioning as communicative arrangements. It opposes the assumption of roles or identities as given and static entities. (Antaki and Widdicombe (eds.) 1998; Mulkay 1997; te Molder 2000, cited in Bora and Hausendorf 2006: 37.)

Linguistic and pragmatic patterns and forms can be analysed with regard to how participants present themselves and act in relation to a certain understanding of social belonging and social membership in a social situation. (Bora and Hausendorf 2006: 38). With respect to the communicative task of social categorisation, the linguistic means participants apply can be located in the surface structures of respective communicative events, such as conversation (Iványi et al. 2006: 238).

According to Alasuutari, categories and descriptions of subject positions can be approached by looking at rhetoric. Rhetorical strategies can be used to strengthen the role these categories or descriptions have in justifying the existing social order. Rhetoric is, in turn, successful when it goes unnoticed. Thus, according to Alasuutari, the legitimizing effect of rhetoric lasts only as long as it remains unnoticed. (Alasuutari 2004: 129.)

According to Alasuutari (2004: 130), when we justify or criticise existing order, we still refer to generally approved principles. In this study, processes can be considered as such sources. According to Alasuutari, in most cases, individuals do not have much choice concerning, which different subject positions they are placed in. Because social positions are also social institutions, they are more or less fixed and ready-made by the surrounding context. Thus, according to Alasuutari, by entering a subject positions participants cannot much affect the conditions that await and affect them. However, people are able to make sense of the position they are placed in. Additionally, Alasuutari acknowledges that context-bound subject positions may lose their legitimating power when situations change. (Alasuutari 2004: 131.)

Power is invested in the presuppositions that are available in some social episode. They provide access repertoires of conduct and serve to distribute duties required to perform necessary actions. (Harré and Moghaddam 2003: 4-5.) According to Harré and Moghaddam, power manifests as the power to position others, but it also figures as the power for one to reposition oneself, or even resist being positioned. (Harré and Moghaddam 2003: 7). Fairclough, Pardoe and Szerszynski (2006: 112) continue that the practices involved in invoking, shifting and constraining subject positions serve to also negotiate and redefine the nature of the social event itself. People, thus, struggle over different genres, and utilise them in this process. Genres can, in turn, make particular subject positions more possible or less possible. (Fairclough, Pardoe and Szerszynski 2006: 112.)

Regarding social events explicitly related to areas of governance, Bora and Hausendorf claim that research into procedural justice has proven empirically that procedures serve to position participants more significantly than the result the procedure. These positions influence the concrete rights and possibilities participants to communicate, participate, and voice. (Bora and Hausendorf 2006: 40-41.)

People identify with the interests, values, beliefs and relations of power that are associated with certain Discourses (Clark and Ivanič 1997: 138 cited by Fairclough, Pardoe and Szerszynski 2006: 113) and subject positions, and create a discoursal self on the basis of them (Fairclough, Pardoe and Szerszynski 2006: 113.)

4.5 Case 1: Factualising quality

The first analysis investigates how facts related to the reported anomaly and its quality were constructed. It investigates what factualisation strategies participants utilised and which rhetorical and argumentative methods were applied in the construction process. The ANT translation process is used to analyse and indicate the phases, i.e. key moments during which new conceptions concerning the anomaly and its quality were introduced and frames the progression of the discourse associated with their factualisation.

At the time the problem was identified and the error report created, the affected umbrella project (Release A) was nearing closure: the deadlines for finalising the project were a couple of months away. The relevant social group, whose software the reported problem manifested in, i.e. the Browser development team, had already released their software feature to the project. Focused exploratory testing of the feature in different language variant software versions was ongoing. Exploratory testing complements scripted testing, both of which serve to assure the quality of commonly used functions and content for determined features.

All software changes were supposed to be introduced through a predefined change management processes: large changes via a requirement management process, and late minor changes via a change request process. In general, when a software feature was released, its development process was considered *Closed*. Closure was also indicated by the *Closed* status of the related requirement in the requirement management tool (RM-RIM tool). The *official* procedure of closure, served to proclaim the feature as mature, i.e. stabilised and having reached a certain level of quality, i.e. market-readiness on behalf of its functionality and content. The claim was usually issued by the software development team, more specifically the *feature responsible*, and proof was usually obtained from the results of the feature's functional testing.

However, this act of closure was in some cases problematic for at least two

reasons. Firstly, most of the time closure referred to the fact that local testing had been completed on the feature with either a non-localised *engineering English* or a similar type of technically more *simple* language version (for example, UK English). Since each language version was supposed to contain only features that were relevant to and usable in that particular language version, in the case of software that was to be further *regionalised*, i.e. adapted to different market areas, how far the status of closure based on this local testing sufficed to indicate the feature's actual market readiness was not self-evident. Then again, testing of language-specific versions happened after the development team's local functional testing was complete. This ensured, among other, that effort was not put on locating and reporting the same problem from multiple realms.

Secondly, as in this case, software features were often ensembles of, or had dependencies to, features or components created by other development teams. In such cases, changes to these other components could have also had effects on the specific feature in question. In this sense closure was in practice achieved only after all dependencies had been stabilised. Due to this dilemma, although features were considered to have been stabilised within the local development environment, and thus mature enough to release to external stakeholders, the communicated status of closure did not necessarily reflect anything more than the level of quality attained at the particular moment of its evaluation, let alone that which would be experienced by a potential end-user receiving software further down the delivery chain. Thus, *unlocking the black-box of technology* and permitting a certain level of *openness to further interpretations* of quality via subsequent testing phases was also usually allowed, and even expected.

Error report: error description

The error report depicted a problem in the Japanese device that hindered the use of a Japanese web-based email service. In more detail, the end-user could not use the service to send an email message because the device failed to

respond to the user clicking on the *send email* button on the service's web page. Within the context of mobile communication, email was, at the time, a particularly popular communication form in Japan, similarly as was SMS (text message) in Europe.

The software package that the alleged error was reported to reside in had been built and integrated by a central build and integration team. The Browser development team whose software the error manifested in had first released, i.e. delivered, the software to this central team, and then the latter had combined the delivery along with those from other teams into a Japanese language variant package. A language variant package contains not only common features that are available in all other language variant packages but also language-specific features that exist reside solely in the certain language variant package in question.

First phase: Problematisation: factualising the existence of the anomaly

When the error report was created, it was automatically assigned to the *Detected* status by the database. In terms of the ANT process of translation, this signified entering the first key moment or phase of translation, i.e. problematisation. The act of filing an error report challenged the prevailing conception of closure, since the software was considered mature unless proven otherwise. It served to question the prevailing notion of workability by identifying a certain phenomenon in the software as an anomaly. From a rhetorical point of view, it figured as an existence claim by bringing the anomaly into common awareness (Charney 2006: 33-34)[17] and labelling it further as an error.

Factualisation strategy of self-observation

The error report started out as a typical error report in both structure and style

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[17] A claim that something exists in the world brings it into existence in the conscious attention of the audience. When existence claims make a phenomenon seem present or salient, the audience is ready to receive and understand other claims about it. (Charney 2006: 33-34.)

abiding basic formal error reporting guidelines. The originator had entered his description of the problem in a specially denoted *Error description* text field. From a rhetorical perspective, the error description functioned as the originator's first-account "testimony" (Charney 2006: 68)[18] of the problem. In general, self-observation formed an elemental factualisation strategy in error reporting. However, the input provided by the originator entailed more than just a recollection of the encounter. The originator implicitly and explicitly mobilized various rhetorical and argumentative methods and complementary factualisation strategies to substantiate the testimony.

Factualisation strategies of expertise and quantification

Appeals to logos, ethos and pathos

The originator drew on three forms of rhetorical appeal to substantiate the factuality of the problem: ethos, i.e. legitimising appeal to the credibility of one's own authority or aligning one's actions with procedures, policies, rules and traditions; logos, i.e. rational appeal to facts including evidence and logical arguments; and a subtle form of pathos, i.e. appeal to emotions, each serving as various influence tactics (Cohen and Gibson 2003: 319-320)[19] with which to elicit supportive responses.

The strategy of expert factualisation

Appeals to ethos

The description appealed to ethos various ways. The truth-value of the originator's interpretation about the software's workability as being erroneous was invested in his credibility as a merited expert, a professional tester. Since the originator was additionally a native Japanese tester testing Japanese software, ethos was strengthened by the value of his tacit knowledge and expectations as a representative of native end-users. The originator

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[18] Testimony refers to a public record of a person's direct observations. Testimonies appear in narratives and descriptions that are attributed either to the author or another observer. The more details the testimony presents, the more convincing it is considered to be. (Charney 2006: 68.)

[19] For a summary of influence tactics, see Cohen and Gibson 2003: 320.

externalised this knowledge capital in the description's test steps, where he elaborated the UI texts he had followed to navigate to the anomaly in both English and Japanese. Together these appeals to ethos realized the strategy of expert factualisation.

Originator:

Description:
Steps:
Step 1. Login using valid ID and password
Step 2. Select [Create message (メールの作成)]
Step 3: Type e-mail address to [To:] field then press [Send (送信)] button

Expected Result:
[Send] button functions

Actual result:
Send button is inactive

Other buttons [Save to draft(下書きフォルダに保存)], [Spelling check(スペルチェック)], [Cancel(キャンセル)] and [Attach file(ファイルを添付)] are also inactive

Attached: probe_YahooJPMail.log

Repro in N.1 wk48 V16 (Japanese) on R

Factualisation strategy of quantification

Logos: evidence: repetition and comparison

Similarly to other forms of instruction giving or procedural discourse (Farkas 1999, as quoted by Rowan 2003: 417)[20], error descriptions were, by default, supposed to illustrate the detailed procedures, steps and methods that the

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[20] Farkas (1999, as quoted by Rowan 2003: 417) defines key components of "procedural discourse". Effective procedural discourse helps the user navigate between four states. These are the goal, i.e. desired state, the state that is a condition for moving to the desired state, i.e. the prerequisite state, the interim state, such as subgoals that we enter as we move toward the goal and states we wish to avoid, i.e. unwanted states. Streamlined instructions are brief and simple and help users keep track of steps that have or need to be taken and aid quick completion of tasks. However, they are ineffective in contexts where users have many decisions to make.

originator had applied to disclose the observed problem. It was supposed to elaborate on the anomaly's symptoms and also clarify how the feature was expected to work. This allowed the latter to be systematically and independently located and confirmed by any external entity.

In addition to providing the steps via which to produce the problem, the originator drew on the method of comparison (Charney 2006: 54)[21] to fortify his testimony, further. He claimed that the problem had also been reproduced in a separate, parallel codeline and, additionally, in the next Japanese software package version. Both repetition and comparison extended the notion of the testimony's validity: the anomaly truly did exist, and by following the steps, anyone else could also see it for themselves.

Logos: extrinsic evidence: data

Rational appeal took the form of extrinsic, empirical evidence. Information on the utilised test environment was given. Further evidence was provided in graphic form as a screenshot that captured the anomaly red-handed as it manifested in the user interface of the device. Finally, evidence was proved in the form of a *trace log*, which had recorded the actions and events that took place in the software during the anomaly's manifestation.

Reference to trace log attachments:

| Originator's name | Date Time | 24.4 Kb | Trace Log File | probe_YahooJPMail.log |
| Originator's name | Date Time | 50.0 Kb | Image File | N.2wk2.jpg |

In rhetorical terms, all the illustrative and descriptive details presented by the originator about the object helped promote the notion of its authenticity (Atkinson 1990; Edwards and Potter 1992, cited in Juhila 1993: 158 and Charney 2006: 68). The acts of naming and describing helped realise it. They helped establish the claim as a fact. (Suoninen 1993: 61 and Charney 2006: 34-

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[21] Comparison: the basic method for locating a causal factor is to compare information related to similar cases which in which some phenomenon was estimated to happen (Charney 2006: 54).

35.) Together, the utilised rhetorical elements served to fulfil the burden of proof needed to substantiate the error's existence. They factualised the problem**.**

The originator's problematisation constructed and factualised the basis for the technological frame of problematic workability proposed around the phenomenon. Additional pathos elements were enrolled, which underlined the significance of the problem. These helped to invoke interest in relevant social groups.

Factualisation strategy of no alternative

Appeals to pathos

Explicitly worded appeals to pathos such as value statements were avoided in the actual description. This served to support the notion of objectivity and formality expected of scientific discourse[22] and similarly characteristic of procedural discourse. However pathos was manifested in the classification of the anomaly's *priority*, which the originator set as *Critical*. Being the highest priority an originator can assign to an error report, this served to evoke a prompt response to the report. Although the act of assigning a priority level was mandatory, not only according to the error handling guidelines but also by virtue of the tool, where it was a compulsory field in the report template, the decision regarding which level to assign the error report to was up to the originator. Selecting the highest level suggested that the originator interpreted the alleged error to pose a serious or inevitable problem for the end-user. There was no other alternative but to resolve the issue, or else the end-user would suffer. The originator also selected the initial target audience of the report by assigning it to the development team whose application, i.e. feature, the error manifested in.

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[22] Latour and Woolgar (1986: 81-84, 152-153) discuss how scientific activity and scientific discourse (logic, reasoning, proof implementation and thought processes) are thought to constitute a realm of fact construction which essentially departs from so-called common-sense based activities attributed to non-scientific realms.

Though on the surface, the report's rhetorical mode was that of giving information, similarly to a news report (Fairclough 1992: 129), it also constituted an appeal to someone. Accompanied by the sense of urgency that was signalled by the report's priority, it set an "agenda for action" (Fairclough 1992: 155-156)[23] around the anomaly and, hence, served as an invitation towards interessement upon the proposed problematisation.

Subject positions

Problematisation sets up a framework for action around the anomaly. It also establishes initial identities and subject positions (Mähring et al. 2004: 214). When the error report was created, it questioned closure and in doing so created initially opposing subject positions between the different actors who were impacted by the issue, i.e. the originator who questioned the prevailing status of closure, the software development team whose software the alleged anomaly resided in and other parties whose interests were at stake.

Second phase: Interessement

The originator succeeded in convincing the targeted relevant social group that the problem deserved further investigation, and the error report was assigned the *In progress* status. In terms of the ANT translation process, the status signified success in evoking interessement around originator's problematic-workability frame (Mähring et al. 2004: 214), as it in practice communicated that the development team was ready to start looking into the problem.

Relevant social groups and initial subject positions

At this point, the relevant social groups consisted of the originator, the team to whom the report was allocated including the browser domain's error manager and browser team's functional testers. At an explicit level, the representatives

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[23]According to Fairclough (1992: 155-156), agendas are usually set at the beginning of interaction, setting the framework for it. The dominant participant generally upholds the agenda throughout the interaction by policing the interaction.

of the relevant groups included themselves into the proposed technological frame by agreeing with the originator about the negative impact the anomaly would have had on the feature's workability: Should the error be valid, it would not only jeopardize the notion of achieved quality, but, also, fail the expectations of the end-users. By accepting the proposed frame, the groups broke the opposing subject positions, which the reports challenge of closure had initially set up. However, accepting the invitation to interessement meant also appropriating the burden of proof in proving or disproving the validity of the issue. Deciding the next move on the alleged anomaly was in the hands of the appropriator.

Factualisation strategies of quantification, expert and no alternative

Interessement entails further approval, and, to use Blumer's expression (1971: 303), legitimation of the anomaly's existence as a fact, After acquiring a necessary degree of respectability, legitimation entitles the fact to consideration in the recognized arenas of public discussion and leads to its further circulation in the organisation as such (Blumer 1971: 303). This serves to induce the next ANT key moment, enrolment (Mähring et al. 2004: 214), where key actors start to enlist other actors and proceed to set up actor networks, which serve to elicit the action deemed necessary to solve the problem. Failed interessement, i.e. refuting the proposed problematisation leads, in turn, to key actors rejecting the anomaly as a fact resulting in closure. Arriving at either outcome first entails either confirming or rejecting the validity of the problematisation. (Mähring et al. 2004: 214.) In the case of this error report two main factualisation strategies were drawn upon in order to establish whether the anomaly existed or not. The first was the strategy of quantification and the second the strategies of expertise. The factualisation strategy of no alternative served to complement the latter.

Factualisation strategy of quantification
Appeals to logos
An apparent attempt to reproduce the problem and evaluate the validity of its

existence began. The method used was another one common to the sphere of scientific discourse: correlation. Whereas comparison means collecting cases or phenomena, which are presumed similar and comparing them to each other, correlation compares multiple factors presumed to influence a specific phenomenon and looks at how a change in one factor over time relates to a change in the other. If a correlation exists between different factors, either the reduction in one factor should be accompanied by the reduction in the other, or inversely the reduction in one factor should be accompanied by an increase in the other. (Charney 2006: 56.) As with comparison, in error analysis correlation is a regularly utilized method for cornering and validating the factuality of an anomaly.

Appeals to logos: empirical evidence through methods of repetition and correlation

The testers of the development team attempted to reproduce the anomaly multiple times with several locally created and centrally created (i.e. release program) R&D (research and development) images. These had been made on different dates and contained, respectively, different software package versions i.e. releases. None of the images that the team itself used, however, contained the Japanese version of the software.

Though software development teams were responsible for the integrity of the language-specific features whose development their domain either implements or enables, or coordinates, they did not necessarily compile or test the language--variant versions of the software in question. This could partially be simply due to challenges in understanding other languages, partially due to the lack of including the associated testing work into the overall scope of the development project. Additionally, creating local software images demanded expertise in combining variating elements, such as UI texts of different languages, and configuring, i.e. activating and deactivating appropriate features. Additionally, some interdependent features required a common synchronised build (a full build), that built and integrated all the relevant

deliveries from different development teams. These full build language packages were usually created by the central build and integration team, at the time of this report, on average, every two weeks.

Out of the, in-total, nine attempts made by the software development domain's own testers to reproduce the problem, the latter was reported to have appeared once in a local western, i.e. non-Japanese image. Though the originator, in turn, had still found the anomaly to be reproducible in a later centrally created R&D Japanese image version, the significance of the Japanese finding was discarded along with the one-time western image finding by, in practice, equating the former image with the latter. The problem was concluded to be a borderline anomaly, and reduced to a temporary occurrence of western image regression. The number of repeatedly working western image cases was considered sufficient evidence (Charney 2006: 57)[24] to question the validity of the originator's problematisation, which had built on repeated and successive findings in Japanese R&D (centrally created) language variant images.

Domain testers' test results:

P1: Western image is ok in instance N.2 R NB week 48, 15.12)

-P2: Western image is not ok in instance N.1 Z NB 18.12)

Pn: Western image is ok in several instances N.1 R and Z NB 21.12 and R&D images)

Originator's test results:

-R1: Japanese image is not ok in instance R&D Rel N.1 wk 48, 14.12)

-R2: Japanese image is not ok in instance R&D Rel N.2 wk 48, 14.12)

-R3: Japanese image is not ok in instance R&D Rel N.1 wk 50, 19.12)

(consecutive Japanese images)

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[24] A sufficient factor is one that is considered enough to induce and effect all by itself (Charney 2006: 57).

Domain Error manager's interpretation:

-R1 AND -R2 AND -R3 = -P2

I.e. Japanese image anomalies (R&D images <u>N.1</u> and <u>N.2</u> week 48, 14.12) and (R&D <u>N.1</u> wk 50, 19.12) are identical to, or instances of Western image anomaly (NB 18.12)

On the surface, the investigation appeared thorough, as would be expected of scientific study. However, a look at the conclusion inducted from the results reveals problems in the interpretation of them. The conclusion took the shape of universal affirmative, i.e. categorical proposition that asserts a relationship between the subjects and predicates (All A's are B) (Cavender and Kahane: 2010: 43). However, the relationship between them was grounded on an analogy, which had been constructed between items that were not similar enough to sustain such an analogy. In this sense, the argument chain, thus exemplified a "fallacy of false analogy" (Bosanac 2009: 8). Instead of induction, this exemplified more so a strategy of reduction, i.e. "forcing a statement in one particular direction" (Latour and Woolgar 1986: 166). As Latour and Woolgar comment (Latour and Woolgar 1986: 173), analogy is a regularly applied format for scientific reasoning, which, however, proves problematic being often based on weak connections between phenomena.

Factualisation strategy of no alternative

When entering a certain frame of action and interaction, subject positions are assigned and assumed (Fairclough 1992, 3-4, 44). Participants bring with them particular dispositions to see, act, and use language, which are closely associated to their social positions. (Dillinger 1995 and Fairclough 2003: 29). Subject positions are also positions of power (Fairclough 1992: 34). When such positions determine what is true or not, as with authority roles, they simultaneously manifest as positions of power. In the error report, power relations materialised in the interaction between the error manager, who represented the dominant party, and the testers, including the originator, who occupied subordinate positions. This setting was reflected in the actual

discursive events. The positions manifested in the activities of analyzing, interpreting and decision-making. The dominance of the error manager in these interactions was complemented by the subordination of the testers.

Factualisation strategies of expertise and no alternative

On the surface, there seemed to be a dialogic pattern of interaction between the testers whose responsibility it was to conduct the experiments and conclude their findings, and the error manager whose responsibility it was to decide the next course of action against the findings. However, the error manager assumed a more integral and authoritative role in the testing process. He gave orders to the testers regarding what environments to test on, whereas the testers responded by providing the resulting data. The positions of dominance and subordination were not, however, confined to giving commands and executing. Though the tester had an active role in the process of validating the issue, the power to formulate (Fairclough 1992: 157-158)[25] and interpret the results, in the role of the expert, was assumed solely by the error manager, who drew the conclusion that the reported error was not valid. The error manager further implemented authoritative power by making the decision on how his interpretation of the results was to be acted upon. Discursive power[26] is accompanied by the power to include, exclude, close or enrol. The report acted here as an apparatus of governance (Silverstone 1999, cited in Fairclough 2003: 34)[27]. By assuming both the role of expert (interpreter) and authority (decision-maker), deciding to have the error report ignored, the error manager actualised the factualisation strategy of *no alternative.*

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[25] During a conversation, a participant may take the opportunity to e.g. summarise or explain what has been said. This serves to formulate it (Sacks 1972: 338, as quoted by Fairclough 1992: 157-158). Formulating can also be used to control and police interaction.

[26] Van Dijk (1989: 49-50) characterises discursive power is an embodiment of social power. Discursive power implies assuming control over discourse itself. Discursive power often manifests as persuasive featuring rhetorical means that serve to promote desired mental representations.

[27] An apparatus of governance recontextualises and transforms social practices. It also itself becomes recontextualised in the interactions of different practices in, for example daily life. It influences how we live. It also influences the meanings we give to our lives. (Silverstone 1999, as quoted by Fairclough 2003: 34.)

The possibility to summarise and offer a specific version of events is a subtle but simultaneously potent form of asymmetry (Fairclough 1992: 203). The positions were reflected also in the discursive style of each positioned subject. The tester provided a personal account of the information utilizing active, voiced first person, whereas the error manager summarised the data and expressed his orders and decisions in the form of brief declarations using voiceless passive: "to be reproduced" "this is not reproducible" "Ignored".

The active voice of the tester contrasted against the passive voice used by the error manager accentuated the power distance between them. Active is the *unmarked* choice, used when there is no specific reason to choose the passive (Fairclough 1992: 182). In general, passive voice supports the authoritiveness (Fairclough 1992: 174), or to quote Latour, to out there-ness (Latour, B. and S. Woolgar 1986: 174-175) of the assertions or orders. It omits agency making authority invisible. Passive is common in formal discourse

and markedly in medico-science discourse (Fairclough 1992: 182). It also serves to reinforce notion of objectivity (Fairclough 1992: 159). The brief declarations underlined the impersonal and decisive nature of managerial interpretations and decisions. Thus, the managerial, formal discursive style supported the dominance or force of the interpretations and decisions. These comprise interpretive protocols (Fairclough 1992: 136), commonly applied in the particular domain of the error handling discourse practice.

Domain Tester IS:

> **15.12.2006 IS**
>
> 3.2 NB dec14 build based on wk 48 R
>
> not able to reproduce a problem

Domain Error manager:

> **18.12.2006 K, EM:** To be retested on the latest N.1m nightly build with Z.

Domain Tester RF:

12/18/2006 <u>RF</u>: reproducible on <u>N.1</u>m nightly build with <u>Z.</u>

Domain Error manager:

18.12.2006 <u>K</u>, EM: This is not reproducible in <u>N.0</u>m with <u>M </u>hw. So this is regression from <u>N.0</u>. To <u>S</u> for further investigation.

Domain Tester V:

19-Dec-2006 <u>V</u>:

From above comments:

<u>N.2 R</u> NB wk48 - Not Reproducible

<u>N.1 R</u> (Japanese) wk50 - Reproducible

<u>N.0m M</u> - Not Reproducible

My findings:

<u>N.1 R</u> NB wk48 - Not Reproducible

I can send an email from <u>R</u> to my <u>N</u> account from mail.yahoo,co.jp....

21-Dec-2006 V:

Retested on <u>R N.1</u> NB

Retested on <u>R N.1</u> RnD

Retested on <u>Z N.1</u> RnD

Retested on <u>Z N.1</u> NB

Not reproducible on all builds. I can send email from mail.yahoo.co.jp to my <u>N </u>email. I tried sending email with attachments, no text in body, and text in body. Used both "send" buttons, top and bottom.

Retested <u>Z</u> builds with <u>R</u> present to verify the testing and it was not reproducible.

Domain Error manager:

21.12.2006 <u>K</u>, EM: Ignored.

Third phase: Closure through redefinition: anomalising the anomaly

Closure was achieved by interpreting the Japanese error to be an anomaly of general western functionality. The large amount of repeatedly ok western image results against the marginal evidence identified in the Japanese image served as proof. The fact was created and the decision to close the investigation based on this fact made.

Other options would have been, for example, to contact the originator for help in the analysis and efforts of reproduction and, in general, provide input for decision-making. However, the originator was excluded from these processes. After the reported error was ignored, the burden of proof was not reassigned. The ability to close an investigation without further consultation and dialogue between the different actors was built into this engineering, and more specifically, error handling discourse practice (Fairclough 1992: 5, 100).[28] and supported by the process. As the issue failed to sustain interessement, alliances fell and networks around the issue dissolved. The problematisation which destabilised the notion of workability was superseded. Interessement lead to closure as further action was not deemed necessary.

Closure involves the stabilization of the artefact into a fact and the disappearance of problems. As Pinch and Bijker state, "to close a technological 'controversy', one need not *solve* the problems in the common sense of the word. The key point is whether the relevant social groups *see* the problem as being solved." (Pinch and Bijker 1987: 44.)

Fourth phase: Reproblematisation and interessement

It was now two months since the problem had been initially reported. The originator reopened the error report insisting that the anomaly still existed in the latest Japanese software versions. This time the software development team checked the Japanese image itself and was able to reproduce the

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[28] According to Fairclough (1992: 5, 100), a discourse practice of particular institutions, organizations or societies serves to structure and restructure orders of discourse.

problem. The team agreed with the originator's original interpretation and confirmed that the anomaly existed in, and only in, the Japanese image version.

This time the investigation progressed to the next translation phase: *enrolment*. As ownership of the error report was appropriated, the roles and responsibilities required to solving the problem were assumed. This meant also enrolling new actors into the problem-solving process, i.e. a parallel Browser development team.

Relevant social groups

The enrolled relevant social groups comprised now of the originator, the original and the parallel browser development teams, and a browser domain error correction board.

Fifth phase: Rhetorical closure: excluding the anomaly by excluding the feature. Redefining the value of the artefact

Until now the explicit technological frame had been a common one. A common notion of workability serves not only to align the interests of relevant social groups, but to also drive their efforts and actions towards a common goal of problem-solving within that frame (Bijker 1995: 123-124). The level of inclusion in this common frame was, however, still low.

Factualisation strategy of no alternative

The investigation was soon halted with the introduction of a new claim. The feature that the now acknowledged anomaly manifested in was deemed redundant, since the feature's target market was asserted to have ceased to exist.

Browser domain Error correction board:

12-Feb-2007, Browser ECB: Set to Not Active. Browser will not be available in the Japan market.

This existence claim was presented in the form of a fact statement. Whereas on its own an existence claim simply makes a phenomenon seem either present or unpresent, in this case it served as a premise within a causal claim (Charney 2006: 51)[29], which was used to justify the decision to deactivate the error investigation. By annihilating the existence of the target market, the feature itself and the anomaly were also annihilated. The claim was translated into a decision to close the investigation and set the report to the status *Not active*.

Appeals to ethos

The decision to close the investigation rested on a claim concerning the value of the feature, or rather lack of it, for the end-users in the Japanese market. Though the board explicitly draws on an expulsion decision in its argumentation, the identity of the person, or people, behind the decision was obscured. This was achieved by depersonalizing the agent, who refers to itself as an entity, i.e. a *board*.

According to Charney (2006: 75), the most frequent way a speaker or author appeals to ethos is by supplying information and credentials about the person whose testimony is being cited. Here, the claim is presented in passive voice, masking the source. It cannot be pinned down to any specific person. Passive voice also serves to hide the statement's overall "intertextual chain" (Fairclough 1992: 130)[30] of reasoning and decision-making. It cannot be traced back to the origin.

In practice, a discussion about the feature's value for end-users and, thus, the relevance of its existence would have had to have taken place elsewhere. A decision to expel a feature from the market would have needed input from

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[29] A cause claim explains why something changes over time. Something starts one way. It is then altered by a factor, and as a result, ends up different. (Charney 2006: 51.)

[30] A series of certain types of texts which are "transformationally related to each other in the sense that each member of the series is transformed into one or more of the others" (Fairclough 1992: 130).

those representing the customers and end-users, especially at this point of the project. The latter are implicitly enrolled as "the Japanese market".

In this context where decision-making roles and hierarchy are institutionalized, intertextual chains of debate and persuasion were not necessarily even expected to be made visible top-down to lower hierarchical levels of actors. Anonymity in turn, accentuates the notion of impersonality (Fairclough 1995: 147) supporting the notion of social hierarchy and the effect of the power distance (Fairclough 2003: 75)[31] between the board, who voices the claim, and the rest of the audience. The statement's persuasional force drew on and resided in the asymmetrical power relationship between the speaker and the assumed audience. Whereas intertextuality can make voices visible, undialogised language is authoritative or absolute (Holquist 1981: 427, as quoted by Fairclough 2003: 42). It can gain a fact-like appearance making it impossible for the audience to assess the factuality of related assertions.

Subject positions

To quote Callon (1999: 78), to "speak for others is to first silence those in whose names we speak." By obscuring the identities of the people behind the decisions, the board appropriated the voice of this hidden group and assumed the role of spokesperson. In this case, its role as animator was replaced with the role of author (Goffman 1981, cited in Fairclough 2003: 12).[32] Appropriating and amalgamating their voices served to appropriate their power and utilize it further to smother the originator's technological frame

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[31] According to Brown and Gilman (1969, cited in Fairclough 2003: 75), social relations vary in two dimensions. These can be either power and solidarity, or social hierarchy and social distance.

[32] According to Fairclough (2003: 12). Goffman (1981) makes a distinction between three different forms of "author agency". The first agent, whose position is placed in the text is the principal, the second agent who links the words together and is responsible for the wording is the author, and the third agent who produces the actual sounds or the marks on paper is the animator. Essentially, an individual can assume all three roles, but in practice, for example, a spokesperson may simply be the mouthpiece for others (animator), or a principle may be someone whose position is implicitly supported in a text. In the case of this error report, "the board" had appropriated all three positions of agency on behalf of the customers.

and dismantle related subject positions. Though the anomaly itself was still valid in itself, its significance was deemed not. The power to signify or de-signify was in the hands of the board. With this act, the dominant discourse shifted away from the question of workability back to the question of existence. This introduced a new technological frame.

Domain Error correction board:

12-Feb-2007, Browser ECB: Set to Not Active. Browser will not be available in the Japan market.

Error manager for language testing team (supplier):

13.02.2007 <u>WC</u> **(** <u>L</u> **EM) :** Set back as To Be Evaluated. According <u>to</u> <u>Company name</u> Variant EM, <u>R&D Unit name</u> Browser is not dropped for the Japanese market.

R&D Variant Error manager:

16.02.2007 <u>LP</u> **-** Proposed for Customers to check this for their PR schedules. According to our testers there is a high risk that this error will in practice affect the maturity experienced by end users.

Product program A's Incident review board:

<16.02.2007, <u>A</u> IRB: >Prioritized by <u>A</u> Program. Targeted to <u>A</u> PR2.0.

Sixth phase: Interessement and enrolment via escalation

According to Latour, the factuality of an object is relative to the network dealing with it (Latour 1986: 107). The dominance of one resulting translation, and the group promoting it, over another depends on how well it succeeds in enrolling strategies, resources and capital to make its frame accepted by others (Callon 1986: 19).

Factualisation strategy of expertise

The report was reopened after the factuality of the claim drawn upon for closure was refuted. The claim turned out to be a presupposition. Outside the error handling process, the claim that the feature had been expelled from the Japanese market was attributed to a misinterpretation (i.e. hasty generalization) by the board which had confused this case with a decision made by an isolated project to replace an existing feature with their own version. The error report attracted a greater audience and became a manifestation of power struggle and political action as the silenced voices emerged and took possession of their own voice.

Relevant social groups

By appropriating the voice of the customers, the board had unintentionally invited new relevant social groups to take part in the discourse. The first was a separate R&D (Variant) error manager within the R&D organization, who, in turn, began to function as a gateway between the already involved parties and new participants. Gateways are links between two actor networks that are alone unable to establish direct interactions (Qlanseth and Monteiro, 1998, as quoted by Mähring et al. 2004: 215).

Factualisation strategy of expertise and no alternative
Appeals to ethos and pathos

The R&D error manager escalated the decision to customer representatives. He enrolled the now dominant technological frame of existence (based on the claim that Browser would not be available in the Japanese market) to gain leverage for the smothered frame of problematic workability (Email cannot be sent from the Japanese web-based email service). Polarising the two frames served to stress the sense of harm and accentuated the sense of powerlessness of the customers in relation to the dominant parties behind the existence claim. This strategy sufficed to arouse interessement in the stakeholders of the feature. As a result, the dominant discourse voiced by the board became superseded by a more dominant one: that voiced by the customer itself, and

further more directly to the audience. Interestingly, also referring to itself as an entity, i.e. a customer project error board (IRB, i.e. incident review board), it voiced its support for the frame of problematic workability. Its discursive style matched that of the development team error correction board: brief and unmodal:

Customer project error board:

<16.02.2007, <u>A</u> IRB: >Prioritized by <u>A</u> Program. Targeted to <u>A</u> PR2.0.

With this act, the value of the feature for customers was reinstated, and any alternate views questioning the nature of the anomaly as a problem were displaced. In three days, the existence technology frame had been smothered, and closure had been reversed.

Seventh phase: Enrolment: accumulating the mass of power to support the view

With the act of escalation, the-end user representatives and relevant social groups were not only evoked as interested bystanders but also enrolled into the error handling process. Similarly, the number of active relevant social groups increased. Each stakeholder explicitly and directly expressed its agreement with the workability frame by marking the fixing target in their "PR2 schedules" This indicated a general commitment towards the goal of getting this issue solved.

Product <u>S</u> Error manager:

23-Apr-07 <u>AL</u> (<u>S</u> EM) Added <u>S</u> as Affected Party.

Product <u>C</u> Error manager:

23-Apr-07 <u>TI</u> (<u>C</u>T Tokyo EM): Added <u>C</u>_Japan on Affected party. This error fix is crutial for our future products for <u>customer SB.</u>

Product Sc Error manager:

> **23-Apr-2007 SM**: similar problem here? Sc V10.0.032 @

[http://wap.oa.yahoo.com]

Factualisation strategy of no alternative

The originator's workability frame gained momentum as representatives of various organizational units began to align themselves with it. As alliances formed around the frame, the latter became the supported regime of truth. Such a régime helps establish the social structure and space needed for problem solving (Callon and Law 1992: 21-22). From now on, the only acceptable path towards closure seemed to be that of fixing the anomaly, thus ensuring the feature corresponded to the expected concept of workability.

Eight phase: Enrolment and mobilisation with urgency

Appeals to pathos, urgency and force

Now that all relevant social groups shared the same interpretation and goals, handling of the issue shifted to the phase of problem-solving, which entailed the further enrolment of new social groups and, finally, progression to the stage of mobilisation.

Relevant social groups

The relevant social groups now comprised the development team of the operating system, two browser development teams, a third, character conversion development team and their managers, i.e. networks of experts, release project error managers, originator, customer projects mainly as the audience, and the error managers that represented them. Active dialogue took place between actors as they "negotiated their roles and identities" (Callon 1986: 12)[33] within the frame. Attempts to enrol and mobilise continued.

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[33] According to the account by Callon (1999: 75-76), actors can be enrolled through physical violence (against predators), seduction, transaction or consent without discussion. The definition and distribution of roles result from multilateral negotiations during which the actor's identity is determined and tested.

Deadlines for getting the problem solved were closing in. As the importance of the issue was escalated, a new discursive style emerged. Team managers partook in the problem-solving discussion, summarising points, intertextually referring to each other's comments and enrolling new actors into the problem-solving process using direct questions.

Manager of the Browser development team:

26.03.2007 AH ... Adding <u>S</u> as responsible, can you answer <u>M's</u> question.

22.03.2007 AH ... Please comment to TT in case this problem is in <u>R&D Unit name</u> code.

Appeals to pathos

Special project related error-handling meetings where the progress of top errors is followed up took place regularly. Project error managers outside of the development team secured the continuity of the mobilisation process by building up a sense of urgency through appeals to pathos. As each project marked up the error report as an important factor for reaching their sales target, urgency was reflected in the accompanying comments with the words "urgent issue", "crucial" and "about to ship", some even appealing to harm, stirring up fear with threats about the potential of getting "very, negative feedback". Together the customers and error managers formed a rhetorical community of urgency. This also served to keep the interests between different actors amalgamated, and ensured the stability of the problem-solving network: There were no other options available but to implement some solution. If the error wasn't fixed, the feedback would be very negative and future projects would be impacted. This sense of urgency, thus, served to guide the prioritisation of work.

R&D Unit Error manager:

12.04.2007 OP (R&D Unit EM): Priority upgraded to Show stopper. Multiple N.1 products about to ship and very negative feed-back to be expected from Japanese market unless solved.

Error manager

17.4.2007: <u>SJ</u>: Urgent issue, please act accordingly.

Product <u>S</u> Error manager:

23-Apr-07 <u>AL</u> (<u>S</u> EM): Added <u>S</u> as Affected Party.

Product <u>C</u> Error manager:

23-Apr-07 <u>TI</u> (<u>C</u> Tokyo EM): Added <u>C</u>_Japan on Affected party. This error fix is crutial for our future products for <u>customer SB.</u>

To some extent, the urgency was also accompanied by a superficial democratisation of discourse (Fairclough 1992: 98, 203, 147, 204). Representatives of the projects spoke out in person, using their names, instead of their titles, which served to lower overt markers of power asymmetry. The notion of dependency that the customer projects had on the development teams was accentuated. Appeals to catastrophe[34] underlining the significance the feature had for the fate of future business, and even pleas of politeness using "please" came into play. These elements emphasized the sense that not only the power to fix the problem, but also that to ensure business success, was in the hands of the experts, and thus was also the responsibility to do whatever it would take.

In relation to subject positions, this emphasised the opposition between actors, who were expected to assume the responsibility to act and the overlooking audience, i.e. the potential victims of non-action. They enhanced a sense of obligation by explicating the effects of possible failure.

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[34] According to Layman (1998: 181), catastrophising refers to an appeal which draws on a cause-effect relationship where a relatively minor incident is considered to lead to a relatively catastrophic outcome. Similar to a slippery slope argument, this also draws on fear.

Factualisation strategy of expertise

The problem was initially understood to relate to character conversion. A character conversion process applies character encoding schemes to determine which character is supposed to be drawn in the screen. Each character encoding version, in turn, defines the characters that are associated with specific character spaces. Whereas one encoding scheme, such as US-ASCII, reserves the character space 0x5C for reverse solidus "\" , Japanese character encoding SHIFT-JIS uses the same space for the Yen sign "¥".

It appeared that solving the problem would not be straightforward, and would, instead, require the joint efforts of multiple development teams. However, though plentiful in dialog, the interaction was not initially collaborative. For three weeks the focus was on debating where the responsibility to fix the problem lay, even though the root cause of the problem had not yet been analysed, let alone agreed on. Two main software components were suggested as possible fix locations and arguments against both options were expressed by the representatives of the respective areas. Drawing on their own expertise to factualise the proposals.

Rhetorical strategies: intrinsic evidence and modal claims

The uncertainty regarding what was the appropriate solution and the lack of information needed to resolve this uncertainty is visible also in the dialog which was rich in modal expressions and turn-taking questions (Fairclough 1992: 147, 160-161 152-154).[35,36]

Each counterpart challenged the other to provide the solution by presupposing what the other should do. These challenges were, however, modally hedged

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[35] Modality markers can tone down the notion of authoritativeness (Fairclough 1992: 147, 160-161).

[36] According to Fairclough (1992: 152-154), turn-taking systems constitute a form of interactional control. Question-response structures can manifest a variety of functions ranging from simple ones, such as asking and responding to questions, but also that of setting out agendas. Turn-taking may differ in different genres and contexts. One example is that of the classroom context.

and in this sense speculative. From an individualistic point of view, epistemic modality markers such as the subjective marker "I think" serve to lower the affinity of the speaker towards the assertion (Fairclough 1992: 158-161 and Nuyts 2001: 29). Similarly, tag questions may be interpreted as hedges that promote solidarity (Fairclough 1992: 159-160).

However, from a rhetorical and interactional viewpoint, tag questions can also figure as methods for appealing to and attempting to enrol the other party (Blum-Kulka et al. 1989, as quoted by Vine 2004: 103), whilst also serving to shift the burden of proof by challenging and provoking the counterpart to act. From a Bakhtian viewpoint, the actual impact of modality markers depends on the dialogical interpretation produced between audience and author ((Finn, Brandist and Faber (eds.) 2005: 91-92) in the "intersection in discourse between the signification of reality and the enactment of social relations" (Fairclough 1992: 160), i.e. the nexus "between the ideational and interpersonal functions" of discourse (Fairclough 1992: 160).

Manager of Browser development team:

   ...suggesting some sort of a hack in charcconv.

Character conversion team developer:

   If charconv cannot be changed, the JavaScript interpreter needs to be changed, I think.

Character conversion team developer:

   21.03.2007 <u>MI:</u> This problem cannot be solved simply in charconv. If charconv is changed, does Browser commit to change to display 0x5c as the yen sign in Japanese pages? Or is there some other solution possible ?

Character conversion team manager:

   I don't think it could be fixed in our version of charconv either as it works as specified.

   Any suggestions?

Each encoding worked as expected when it was separately activated in an isolated context. However, some contexts also contain *subcontexts* which, when reached, require the software to activate alternate encodings. The question was how to have the relevant conversion activated in the needed context.

The Browser feature representatives attempted to attribute the problem to a lower level, i.e. operating system-originated. Their suggestion to have the solution implemented in the operating system was, nonetheless, not accepted by character conversion representatives, since the character converter component under question had already been *branched* from the generic software base. In addition, a change there would have caused the character 0x5C to be interpreted solely as a backslash, i.e. reverse solidus, by default and this, in turn, meant that Browser application would need to replace it with a Yen sign whenever it was being used in the Japanese software version. A proposal by character conversion representatives to have Browser or JavaScript components check whether each instance of 0x5C would require a backslash or a Yen sign during the rendering of the character on the screen was argumented against by Browser representatives as causing the performance of the software the slow down. A third solution proposed by Browser to "hack" the character conversion component itself was rejected by the component representatives. The owner of the component was not willing to make alterations, since each standard, in isolation, was supported as expected and worked, in an isolated context as specified. The discussion reached a stalemate as none of the offered solutions succeeded in gaining support.

The word ping-pong is often used in software development to characterise a situation where neither participant assumes responsibility. Reasons for such a stalemate may be varied: interestingly, assuming responsibility also leads in practice to the situation where the active error reports in your area are statistically *counted against you*. They reflect quality problems for the stakeholders and thus can result in negative publicity.

At this point an external participant from a customer project partook in the debate. There was already pressure to finalise the software. It was still not clear where in the conversion process the problem actually emerged or why. Drawing on historical and tacit knowledge about similar Japanese problems in Browser features, the new participant assumed the roles of expert and mediator.

Ninth phase: Mobilisation

Factualisation strategies of self observation, quantification and expertise Appeals to logos and ethos

The new participant analyzed the source web page that contained the source Java script. He found no Japanese characters in the web page source but he did find that the Java scripts contained character 0x5C shown as a backslash. Based on these observations, he then deducted that all the backslashes were being converted into Yen signs when the script was interpreted by the JavaScript interpreter. This prevented the script from being executed correctly and this in turn manifested as the unresponsive send button in the rendered page of the web-based email service.

Testing the software helped him, further, pinpoint the specific process where the anomaly surfaced. The participant verified his conclusion about the root cause of the problem with three target questions:

External expert:

2-Apr-2007 <u>JK</u>:

Questions:

- Which component is running the encoding conversion for JavaScript content?

- Is the whole JavaScript code going through the conversion process or is it just the portions that are defined as text strings inside JavaScript content?

- Should JavaScript code be parsed so that escape codes would be parsed first before converting encodings?

He commented further on the earlier offered solutions. Having the Yen sign interpreted only as backslash would not be acceptable to Japanese users who were expecting to see Yen i.e. currency signs. Then again, having the backslash always interpreted as a Yen sign would mean that the backslash would not be rendered as expected in Japanese products. Additionally, a change to support conversion of the specifically SHIFT-JIS version of 0x5C, i.e. the Yen sign, into the Unicode version of the Yen sign U+00A5 had already been implemented and supported since the introduction of the first Japanese language version a few years earlier, leaving the US-ASCII backslash version alone.

In response to the questions, Browser development representatives confirmed that if the browser web page contained Inline Java script (Java script embedded in the html) and if the page was to be encoded in SHIFT-JIS i.e. displaying Japanese characters, the Inline JavaScript code was as a whole processed through the character conversion process before a script node was created, i.e. made into executable form, then the backslashes in the Inline Java code, also those part of the code were converted into Yen signs.

Character conversion team developer:

For clarification, the requirements for Browser are:

- If page encoding is Shift-JIS/ISO-2022/EUC-JP, 0x5c should be rendered as a yen sign in Browser page? but should work as backslash in JavaScript.
- If the page encoding is Unicode, U+005c should work as a backslash and U+00a5 should work as a yen sign.

The problem was finally understood relate to three separate character encoding standards. Two of them, as mentioned earlier, have a different character assigned to the same character space. In US-ASCII the character space 0x5C is reserved for the reverse solidus "\", i.e. backslash whereas in Japanese specific SHIFT-JIS encoding, the character space 0x5C is occupied by the Yen sign "¥". However, in Unicode, the reverse solidus is assigned to

character space U+005C (to be exact, a half width, i.e. narrow reverse solidus, which takes half the space of the full-width, i.e. wider version), whereas the Yen sign "¥" occupies character space U+00A5. To add to the confusion, Unicode character space U+005C is often abbreviated in everyday language to 05C

This type of encoding overlap had not been accounted for in the features' current development. The problem translated into the question of how to make the conversion system sensitive to the differing needs of the applications that utilized it (i.e. the interdependencies between the conversion process and each feature) and how to make the applications indicate which encoding scheme was needed.

A correction was to be implemented in two places:

The character converter would convert 0x5c to U+005C i.e. backslash only when it was called (i.e. requested) from the Browser application.

Browser and JavaScript interpreter would call the character converter when backslashes were supposed to be rendered as yen signs.

Ethos of expertise

As with the originator, expertise in the subject matter was grounded in the participant's ethos, his credibility as an expert in his area with the ability to analyse data, apply experience in interpreting observations and ask the relevant questions to corner the issue at hand. Leading to an acceptable solution, ethos, in effect, actualized the factualisation strategy of expertise.

Tenth phase: Closure through consensus

As the facts were agreed on, a space of negotiation emerged. This made collaborative problem-solving possible. The options accepted by all participants meant implementing changes in both domains, i.e. Browser and

Character conversion. Regimes and networks of knowledge were enrolled, mobilised and reproduced. Needed roles were stabilised in the expert framework. Implementation of the solution took off as all actors strove for the common goal.

4.6 Case 2: Framing quality

The following, second analysis centres on how the anomaly in question and the conceptions of its quality became framed by different parties and investigates how the frames developed, also in relation to each other. It studies the rhetoric and argumentation methods that participants utilised to enrol other participants into their respective frames and displace the frames of others.

Chain 1: Problematisation and interessement

The second error report dealt with a software performance problem. When utilizing a specific email setup, the software's overall responsiveness was reported to become sluggish and to lead, ultimately, to the full halt of the email handling process. The reporter, i.e. originator, claimed to have encountered this issue when using an email account, which was linked to a UNIX account that had a large amount of files situated in the home directory of the UNIX shell account[37]. According to the originator, the problem only occurred when the email feature was set to continue operating in the background[38].

The originator provided various input to support his claims. As external evidence, logos, he provided trace data logs registering the events that took place between the server and the email feature during the process of data transfer. He also provided a screencaptured animation of the anomaly for viewing. He drew on ethos, based on his credibility as a professional tester and, also assuming the role of expert in the matter, he provided intrinsic evidence[39] by presenting what he deducted to be the cause of the problem and

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[37] The home directory that the problem was located in contained 14 directories, and 48 dot-files and directories (hidden files and directories whose names begin with a dot) amounting to a total of 512 Mb of data (which would almost fill a regular CD).

[38] For example, when starting to use a different application while still keeping the first open.

[39] In classical rhetoric, two sources of proofs are identified: proofs drawn from the subject itself are intrinsic proofs and proofs drawn from considerations external to it (Doyle 1893: 15).

proposing a solution to it: "I think that the problem is that the imap client is trying to scan the whole home directory"

In practice, the reporter started out by contemplating on what issues could impact the performance. Although he did not go so far as to speculate what the *root cause* of the problem could be, he did conclude that the problem was connected to the amount of data that had to be processed by the email feature. He moved on to propose a "workaround", which aimed to reduce the data load, as a solution to the problem. He suggested that access be limited to files located only in a specific "INBOX" folder: "A simple workaround is to change "Unix path" to "INBOX."" This solution was supposed to reduce the amount of data that needed to be processed and, consequently, speed up the overall performance.

Introducing the sufficient-quality frame

The proposed workaround served as a basis for the formation of, what is called here, the sufficient-quality frame. Its approach to solving the problem revolved around identifying and promoting the implementation of a solution that enhanced the performance adequately. It constituted the first of two alternate technological solutions in the frame, and it is here labelled as the *maximum low-effort technological solution*. The key elements and characteristics of the frame at this point are summarised in the table below.

Frame of sufficient quality (1a)	
Nature of anomaly	Error artifact
Impact of anomaly	Hinders usage of email in specific use-case
Relevant social groups **[Enrolled allies (A) Excluded parties (E)]**	(A) Originator (Customer project)
	(E) Email end-users with lots of data in home directory of UNIX shell acount
Solution type	Workaround (maximum low effort)

Table 2. Sufficient-quality frame's key elements and characteristics.

Enrolment

The originator was a member of a customer project that belonged to a separate organizational unit from that of the software development team responsible for the feature's implementation and quality. The problem was, however, located using the customer project's software package, and instead of assigning the report to the software development team for investigation, the reporter initially assigned it to the error management contacts of the customer project. A week later another member of the customer project conducted further comparative testing of the reported anomaly against two other packages: an R&D software version and an intermediate software version developed by the software development team (the latter combined lower level components, such as hardware specific drivers with the software), and found the problem to persist.

According to the process guidelines, if an error had been located in a software package made outside of the R&D development chain, in the customer project, the error case should have been automatically and immediately cross-checked against a R&D software package created within the R&D development chain. The purpose of this would have been to help identify directly whether the problem resided in the original software implementation (e.g. the code) or whether it could have been, for example, related to some later applied compilation process or end-environment (e.g. a later made separate software image or device version). The responsibility of dealing with the problem would have, then, been shifted accordingly to the team whose activities the problem seemed to result from.

Introducing the necessary-quality frame

Building on the originator's description, a second customer project member went on to analyse and describe which phase of the email retrieval process the problem originated in. Drawing on the logos of this testimony and presenting related data, he then concluded that the problem resided in the original software implementation, and assigned the error report accordingly to the software development team's responsibility.

Mobilisation: piling up the evidence

An error manager and a project manager of the customer project added further intrinsic evidence to support the validity of the latest interpretation by claiming that the anomaly had also been reproduced in products based on earlier software releases (approximately a year older) that had been used in preceding customer projects. They deducted, further, that the anomaly was inherited from the original software versions.

As more data accumulated around the alleged error, the customer project's error manager enrolled herself into the problematisation. She underlined the severity of the issue by concluding that the device would be rendered unusable if the user had a certain type of email account.

Customer project error manager:

> 4.1.2007 <u>EB</u> (<u>Products T/A</u>): Proposed to branch and <u>Product A</u> IRB priority raised to showstopper. This error makes <u>device</u> practically unusable if the user has a certain type of mail account.

Drawing on this claim to catastrophe[40], she escalated the error report's priority to that of a *showstopper* for the customer project. This signalled an attempt to recruit and mobilise stakeholders and agents around the interpretation.

The high level of threat or harm that this problematisation depicted the anomaly to have provided the grounds for establishing an alternate frame, here called the *necessary-quality*, frame, which was to be constructed further. The key elements and characteristics of the necessary-quality frame at this point are summarised below.

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[40] According to Layman (1998: 181), catastrophising refers to an appeal which draws on a cause-effect relationship where a relatively minor incident is considered to lead to a relatively catastrophic outcome. Similar to a slippery slope argument, this also draws on fear.

Frame of necessary quality (2a)	
Nature of anomaly	Error artefact
Impact of anomaly	Prevent usage of device in specific use case
Relevant social groups [Enrolled allies (A) Excluded parties (E)]	(A) Error manager and project manager (Customer project)
	(A) Email end-users with lots of data in home directory of UNIX shell acount
Solution type	Workaround (maximum low effort)

Table 3. Necessary-quality frame's key elements and characteristics.

This level of escalation and rhetoric could be, in some sense, considered exaggerated. However, in practice, at this final phase of the development chain when the customer projects were to take the already developed and maturised software into use, only severe errors would be fixed. This was relevant, not simply to keep deadlines *per se*, but also achieved quality: changes in one part of the software could induce complications in other parts resulting, in turn, in the need to administer further corrections or changes. Hence the saying, "if it isn't broken, don't break it". Then again, now that the software and hardware packages were more robust, a less stringent type of out-of-the-box end-user type testing could take place, which could lead to further error findings. Change-decisions would, however, require more consolidation or evaluation than earlier. Additionally, error counts and related targets would be monitored more intensively in order to determine the earliest time acceptable quality was reached. Each error report in the so-called error backlog marked a step backwards from achieving the deadlines and targets.

Chain 2: Problematisation, Interessement

Attempt to bring closure by redefining the anomaly

The case failed to evoke interessement in the R&D entity. The software development unit's error manager displaced the proposed problematisation speculating that the anomaly could have been a duplicate of another reported error, where the problem had been attributed to issues with a Linux server, and not requiring fixes at least in the lower-level operating system software.

Based on this analogy constructed between the Linux and UNIX server related cases, he concluded that since this issue was already known and, in practice, the workability accepted as such, no further action was necessary.

R&D Unit error manager:

> 04.01.2007 PR (R&D Unit): I think this is related to (if not exactly a dupe of) Error report ID which was not fixed by Operating system developer

(By enrolling this other report into the discourse, the error manager had simultaneously introduced it, unintentionally, as a tool for opponents to refute this closure attempt later on.)

While the maximum low-effort solution of the sufficient-quality frame promoted making changes to the software, which would require resources, i.e. work effort, and time, the new proposal for closure based on non-action is here considered to provide the *minimum low-effort technological solution* option of the sufficient-quality frame, i.e. that requiring the least effort to construct a workable object. The changes introduced to the key elements and characteristics of the sufficient-quality frame are summarised in the following table.

Frame of sufficient quality (1b)	
Nature of anomaly	Duplicate error artefact
Impact of anomaly	Known issue, not a problem
Relevant social groups **[Enrolled allies (A) Excluded parties (E)]**	(A) Error manager (R&D)
	(A) Linux error report
	(E) Email end-users using Linux or UNIX servers with email
Solution type	Closure (minimum low effort)

Table 4. Sufficient-quality frame's key elements and characteristics.

The originator set out to refute the attempt to redefine the UNIX anomaly as a duplicate of the Linux case. He claimed that the conclusion of identifying the

former with the latter was not valid, since the error he himself had encountered manifested specifically in the UNIX environment.

Originator:

04.01.2007 <u>AL</u> (<u>Products T/A</u>): That is mostly the same case. However, there are some issues with that error:

1) I have reproduced this error also with <u>S 10</u>, so it is not only a problem with Linux servers.

He also claimed that when using other email clients, including that in an older release software package dating a couple of years back, the scenario did work as expected. He refrained from explicating the source of this claim, hence leaving it open as a presupposition. He also failed to provide evidence about the other allegedly working cases. He, however, did refer to and, thus, enrol into his argumentation a third-party application with which the problem had not surfaced, using it as evidence against the analogy drawn by R&D error manager between Linux and UNIX server related cases.

Originator:

05.01.2007 <u>AL</u> (<u>Products T/A</u>): There is also a 3rd party application that works correctly in <u>Product A</u> with the problematic mail boxes.

He further, deducted that since, according to the trace logs, the file list from the mail server was handled correctly, the problem with the UI getting jammed was not related to any server issue. This supported the interpretation that the anomaly was unrelated to previous cases.

Enrolment by escalation: pathos

The originator enrolled the interests of the end-users into the argumentation by drawing on the Linux server issue report's comment: "the user has probably no idea why the e-mail application jams and does not know how to

set a workaround (the IMAP4 folder path setting)" Drawing on the potential harm this would have for users, this claim served to escalate the issue and drive the problematisation towards interessement. This claim simultaneously strengthened the pathos, i.e. emotional persuasiveness, of the necessary-quality frame, while refuting the usefulness of the sufficient-quality frame's maximum low-effort technological solution. The frame in its current form is elaborated in the table below.

Frame of necessary quality (2b)	
Nature of anomaly	Unique error artefact
Impact of anomaly	Prevent usage of email in specific use case
Relevant social groups **[Enrolled allies (A) Excluded parties (E)]**	(A) Error manager (Customer project)
	(A) Project manager (Customer project)
	(A) Email end-users with lots of data in home directory of UNIX shell acount
	(A) Third party email application
Solution type	Other than workaround

Table 5. Necessary-quality frame's key elements and characteristics.

Chain 3: Interessement

Within a week of the escalation, a developer in the email development team accepted the invitation to interessement and began investigating the problem. He found the problem to exist also in the original common code-base implementation from which the current version had been branched, and he provided trace logs of the finding. These disclosed memory allocation problems in the email application's engine.

Attempt to bring closure by redefining the anomaly, and introducing it as a new artefact

Until this point, the anomaly had been treated by all parties and in both frames as an error of some sort. However, the next day interessement around this conception was displaced. The email developer did not refute the existence of the anomaly in itself, but rather its nature. He redefined it as an engine-related

"feature". Re-categorising the anomaly as a feature, thus, introduced it as a new type of artefact.

According to Bijker (1987: 183) and Bijker and Pinch (1987: 44), if an artefact belonging to one frame fails to offer a solution that is considered appealing to a powerful social group, the problem may be redefined. Additionally, actors who have high inclusion in a certain technological frame will also promote inventions that are conventional of that frame. More *radical* inventions e.g. when dealing with functional failures are usually introduced by those whose inclusion in the frame is low. (Bijker 1987: 183.)

In the error handling context, re-categorising an error as a feature meant it was, in practice, considered to constitute a correct form of functionality. Changes to features were usually introduced through the change request process, and the approval of new change requests and implementation of approved ones was usually prioritized lower than the correction of acknowledged errors. This typically translated into rejecting or postponing change request proposals, especially when introduced late in the project, and longer delivery times for approved alterations.[41]

Nevertheless, the developer did recognize the practical problem that the functionality posed for end-users and their expectations of workability, and, accordingly, moved on to propose a solution to counteract this issue. He suggested implementing the workaround as proposed by the originator, i.e. the sufficient-quality frame's maximum low-effort technological solution, to improve the performance.

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[41] In practice this would also have displaced the developer's role in terms of his liability in the matter: Changing the way a feature worked would not have the same meaning as an error fix to a problem caused by the development, it would, instead, be the matter of implementing new functionality commissioned from him.

Interessement: attempt to enrol audience into the sufficient-quality frame

The developer attempted to enrol the audience into the sufficient-quality frame by persuading it to accept the solution. He did this using a multitude of arguments and methods of appeal. By drawing on past discourse (argument from repetition[42]), he deflected the relevance of further debate around the matter: The nature of the anomaly and the issues surrounding it had already been deliberated and addressed earlier, and, thus, the conclusions reached sufficed to apply to the current situation (appeal to tradition[43]). He claimed there was little time left to solve the issue, and this, in turn, limited the possible courses of action (appeal to harm[44] and consequence[45]). He enrolled the anomaly as an ally: classifying it as a feature instead of an error meant that any changes wished to it would require special action (through the change request process) and, thus, take time of its own. He appealed to the audience using "we" presupposing and persuading it to identify with his, the speaker's, concerns and suggestions. He, finally, portrayed the workaround as providing a simple solution to all the earlier-mentioned challenges. This, in turn, served to make the option of implementing a correction seem less viable by framing it a more complex solution. He, further, limited the scope of harm that the simple solution had to only affect users of this specific use-case, which, in, turn served to downplay the significance of their needs and displace their position in the matter as significant stakeholders. Drawing on all the presented premises the investigator arrived at the conclusion that the workaround was the appropriate solution. The multitude of allies enrolled in support of the sufficiency frame are presented in Table 6.

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[42] Appeals to the notion that something is more likely to be true if it has been often heard. Repeating or referring to repetition does not supply additional evidence or support, but it serves to erode critical opposition and make the point be likely to be accepted (Pirie 2006: 111.)

[43] Appealing to the respect for some tradition that supports their view, rather than evidence (Walton: 1999: 83)

[44] The premises of an appeal to force or harm express or instill fear. The related conclusion has to be accepted because bad things will otherwise happen (Govier 2010: 175)

[45] For more on consequence appeals, see more in Walton 1996: 205.

Frame of sufficient quality (1c)	
Nature of anomaly	Feature
Impact of anomaly	Hinder usage of email in specific use case (IMAP folders)
Relevant social groups **[Enrolled allies (A) Excluded parties (E)]**	(A) Developer (R&D)
	(A) "We" i.e. the audience
	(A) Slow and complex process
	(A) Earlier deliberation
	(A) Anomaly as a feature
	(A) Schedule, i.e. time
	(E) Email end-users with other IMAP folders
Solution type	Workaround (maximum low effort)

Table 6. Sufficient-quality frame's key elements and characteristics.

Here is a summary of the arguments and appeals utilised by the developer:

- We have been through this

(argument from repetition: past deliberation justifies current conceptions)

- It is a feature in the engine side probably needing a CR

(redefining the anomaly as feature)

- Having any correction from OS deliverer will take its time
- The schedule is too tight against the available time

(appeals to urgency and harm[46])

- The solution has a cost: if the default value will be changed to "Inbox" that causes you can't subscribe to any other IMAP folders.
- we need to find a golden mean

(enrolling the audience, "we"; appeal to golden mean[47])

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[46] According to Walton (2000: 173), harm and urgency can be considered aspects of danger arguments. Danger arguments have a force and urgency that mobilises attention.

[47] The best solution is somewhere in the middle of two extremes (Tittle 2011: 132).

- A simple workaround is available

(consolation argument[48])

Conclusion:

- Change the IMAP folder path setting from value Unix path to "Inbox".

The solution was depicted as a compromise, i.e. a golden mean that balanced costs against benefits. The cost of the workaround would be to exclude the needs of a particular group of end-users, i.e. those who keep content saved also in other folders than Inbox. The benefit would be in the speed with which the solution could be implemented, resulting in the possibility to keep project deadlines, which, in turn, would benefit all end-users. Complexity was equated with the failure to meet schedules and the failure to serve any customers in time at all, simplicity, in turn, with success in achieving the schedules and meeting the expectations of most customers.

Interessement and enrolment of more actors into the necessary-quality frame

The developer's solution was not accepted by the counterparts of the debate, and this lead to the necessity-frame being escalated. The originator enrolled new participants from a subproject into the debate by adding their project name to the error report's *affected parties* field. Additionally, a senior developer from the customer project enrolled himself into the debate. He rejected the solution proposed by the email developer claiming it was "just hiding the problem, not correcting it -> not acceptable." By doing so, he simultaneously displaced the acceptability of the sufficient-quality frame.

Interessement and enrolment of affected parties

Until this point the problem had been considered to impact only the group of end-users who stored emails in multiple folders within UNIX shell accounts.

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[48] Consolation arguments keep eye on bright side of things. They remove some abuse, which would result in suffering more than equivalent to enjoyment. (Bentham 1824 :194.)

The senior developer, however, extended the boundaries of the effected end-user group by claiming that all "mail heavy users are facing this immediately". By generalising the effect of the impact and the inevitability of facing the issue in everyday use, he depicted more, if not potentially all, email users to be possible victims of the problem, since anyone with lots of email exchange would suffer. This escalated the impact of harm. This argument (appeal to numbers[49]) was supposed to have been accepted because an even larger number of people would subscribe to it. He also enrolled, as an ally, the successfully working third-party email application airing the question "why this profi mail is working" in the same situation?", which repeated the association the originator had drawn between this latter working application and the faulty one now reported on. This contradiction made the frames of necessity versus sufficiency became polarized. The anomaly became re-categorised an error, not a feature, since it meant that once working software had been broken. This displaced the rationale for accepting the sufficiency frame and its solutions. The necessary-quality frame is summarised below.

Frame of necessary quality (2c)	
Nature of anomaly	Error
Impact of anomaly	All mail heavy users will face the error
Relevant social groups **[Enrolled allies (A) Excluded parties (E)]**	(A) Senior Developer (Customer project)
	(A) Originator (Customer project)
	(A) Customer project representatives
	(A) All email heavy users
	(A) Third party email application
Solution type	Other than workaround

Table 7. Necessary-quality frame's key elements and characteristics.

In addition to polarizing the frames' conceptions of the essential nature of the anomaly, the debate brought into light a struggle over what the level and nature of acceptable workability should be: that related to the benefits of

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[49] Appeal to numbers justifies a point by appealing to its popularity (Walton 1999: 89).

sufficient quality versus those of the frame of necessary quality: whereas for proponents of the sufficient-quality frame, project schedules, i.e. time, constructed a central factor for determining the acceptable solution to the problem, in the necessary-quality frame, the defining criterion was the ability to cover the needs of all affected users and use cases.

Sufficient workability implied excluding a certain group of end-users and use-cases for the benefit of project schedules. Necessary workability, in turn, meant satisfying the needs of all potential end-users and implementing the solution which provided the greatest level of coverage irrespective of the project schedules,. These frames were, in this sense, dichotomous, and what followed were mutual attempts by the proponents of the respective frames to displace interessement for the others' frame.

The dichotomy is reflected in the polarised positioning of participants around the frames. The R&D experts, who were involved in the feature's implementation, supported the sufficient-quality frame, the customer projects, in turn, supported the necessary-quality frame. Thus, the contest of interpretations and frames was also a contest of strength between two separately aligned organisational entities: those who were closer to the actual process of software development and those who were closer to the customer.

The battle of the frames

The manager of the software development team partook in the discussion. He refuted the extent of harm that the anomaly was presumed to cause as understood by the necessary-quality frame by lowering the bar for what constituted sufficient quality. He did this by enrolling the experiences of historical users (appeal to tradition): since the problem had already existed for approximately four years, it meant the software functionality had been adequate for customers as such. The anomaly did not constitute significant

harm for end-users.[50]

He pointed out what there was already in place to be thankful for with current workability that provided a method for the user to bypass the problem (a consolation argument): "there is a work around available (FolderPath in Settings)"

He also introduced a new factor in support of the sufficient-quality frame: the risk that the change proposed by the necessary-quality frame proponents posed to the already achieved level of software workability. Making changes to the software could induce unpredictable effects such as new errors. Thus, the current workability in itself was considered sufficient:

Software development team manager:
> there is a work around available
> there will not evidently (modality) be a safe & quick correction.

This argumentation served to refute the force and urgency of the necessity frame. The manager also, however, attempted to clear space (negotiation space[51]) for evaluating the issue further.

Software development team manager:
> Gives us at least proper time to discuss with <u>operating system developer/provider</u>.

He, though, cautioned that any change could still be rejected even after the clarification had been done. Getting more time would not automatically infer

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[50] This actually contradicted the claim of the originator that the mail client in from a couple of years back worked correctly.

[51] Within a negotiation space time and space are made available to a local network, so that it may work towards constructing a working artefact. Resources are enabled or made available for the network. A global network that has an impact on enabling space may be also a direct stakeholder for the resulting artefact. (Law and Callon 1992: 42.)

switching to the solutions or goals of the necessary-quality frame. Reserving room for contingency ensured that potential solutions would not be automatically assumed to consist of those proposed by the latter frame. The sufficient-quality frame's current key form is summarised in the following table.

Frame of sufficient quality (1d)	
Nature of anomaly	Insignificant error
Impact of anomaly	No significant harm for end users
Relevant social groups [Enrolled allies (A) Excluded parties (E)]	(A) Manager (R&D)
	(A) Developer (R&D)
	(A) Historical users
	(A) Current workaround (possibility to set FolderPath)
	(A) Risk of new errors
Solution type	Workaround (maximum low effort)

Table 8. Sufficient-quality frame's key elements and characteristics.

Keeping up the original interessement via appeals to urgency and necessity

The customer project's senior developer denied the manager's request for space drawing on and, hence, enrolling comments from the proposed duplicate: "According to proposed dublicate there has been enough time from last summer to fix the issue." This appeal to irrelevant, i.e. false criteria[52], not only mitigated the value of the request, but also, simultaneously, displaced the value of the criterion to reach schedules against that of satisfying the needs of end-users.

The senior developer enrolled, via a modally hedged presupposition about it, the email client, which he suggested to have worked correctly in a software package from a couple of years back:

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[52] This applies irrelevant criteria of the past to refute the subject of the argument, in this case, time needed in the future for problem solving Gensler, H.J. 2002: 550).

Senior developer:

> 11.1.2007 JK: I think M.2 products are working correctly, as commented in 4.1.2007.

He enrolled the totality of end users to refute the acceptability of the workaround for them. Even though the workaround would restrict the amount of locations being scanned to one, the end-users would still not know why the scanning operation took time.

Senior developer:

> Only problem in this workaround is that end users cannot know what causes this. End user is only seeing "updating" note, no any error or warning notes where they can start to 'debug' problem.

These arguments served to keep enrolment and mobilisation around the issue going. Shortly, a couple more customer projects included and enrolled themselves with the necessity frame. The final form of the winning frame of necessary quality is elaborated in Table 9.

Frame of necessary quality (2d)	
Nature of anomaly	Error
Impact of anomaly	End-users
Relevant social groups [Enrolled allies (A) Excluded parties (E)]	(A) Senior developer (Customer project)
	(A) Email client in old software
	(A) End users
	(A) More customer projects
Solution type	Fix

Table 9. Necessary-quality frame's key elements and characteristics.

Enrolment via escalation

The necessary-quality frame's problematisation and solution were deemed as the ones to be abided and implemented. This served to align interests and

efforts in one direction. A space of negotiation was agreed permitting the operating system provider to investigate the problem further. The provider identified two anomalies which the provider's representative acknowledged to be errors contributing to the slowness. The provider then moved on to deliver the needed fixes. A month later these were also made available for customer projects. However in the meantime other customer refrained from taking the fixes into their software versions, which meant they considered the level of software quality promoted by the sufficient-quality frame adequate.

Mobilisation and closure

Finally four customer projects out of seven did take the fix. Two of those who took the fix were subprojects of the third, i.e. originator project. One of the projects that did not take the fix explicated that there were "not enough buisness reasons". In the end, just over half of the customer projects identified with the sufficiency frame and just below half with the necessity frame.

Further memory related issues were located after the fixes were implemented, and based on initial comments, customer program components were involved in causing these problems. The concerns about further risks and their impact on schedules were in this sense actualised. However, information on whether the problems were acceptable or not for the customer projects was not given, neither was is information on how valuable the fix really was for the end-users in the end.

4.7 Case 3: Positioning quality

The third, and final analysis investigates how the interpretations and conceptions of an anomaly's workability are constructed through the acts of positioning. It looks at how participants positioned themselves and each other in order to gain support for or displace certain solution frames and their solutions regarding the anomaly. It looks at the discursive strategies of rhetoric and argumentation and social strategies of enrolment (ANT) and alliance building that agents utilised to influence others and position themselves and others in the struggle over certain solutions.

Problematisation and interessement: first attempt

The error report dealt with a common problem affecting the texts of two Calendar notifications located in the Russian user interface. According to the originator the word order of the texts in the notifications was incorrect. Below are the original texts that comprise the alleged word-order anomalies. They form error artefact 1. The problematic texts are bolded. The English translations of the texts are presented above each original version.

Note 1.

English translation:

The calendar entry is changed **in the db (abbreviation of database) by another user.**

Original Russian text:

Запись календаря изменена **из БД данных другим пользователем.**

Note 2.

English translation:

The calendar entry is deleted **of the database by another user.**

Original Russian text:

Запись календаря удалена **в БД данных другим пользователем.**

The actors who took part in the investigation were the originator, two localisation language coordinators, who each assumed the role of error manager, and the localiser, referred to in the error report also as translator. The task of the localiser is to translate an English text into the target language in such a way that it is applied consistently throughout all the software features and fits into the user interface.

Appealing to logos, the originator explicated the notes as they appeared in the device's screen and added the steps with which to reproduce the problem. The credibility of the originator as a native tester, an element of ethos, served to support his assertion. The originator provided his own solution for correct wording, which, as an expression of knowledge regarding the anomaly, served to inscribe properties of expertise onto the originator's self. Below are the originator's solutions, and the respective translations, forming artefact 2. Table 10 summarises the positioning elements applied by the originator.

Note 1.
by another user in the database
другим пользователем из базы данных.

Note 2.
by another user of the database
другим пользователем в базе данных.

Originator's positioning strategy, key elements	
Criteria for quality	Correct word order
Solution	Artifact 2 with new word order
Obstacle to displace	Artifact 1
Participants' current positions relative to this solution frame	
* Included in frame	Originator
Main rhetorical & argumentative strategies used to assert positions:	Ethos (professional credibility) Logos (explicated steps and results)

Table 10. Originator's positioning strategy

Closure via counter-problematisation. Introducing new criteria for correctness

The first attempt to invoke interessement failed. Drawing on his ethos as a professional localiser and logos by referring to self-observed empirical evidence, the localiser displaced the proposed problematisation with his own counter problematisation: "Your suggestions do not fit the current layout" This simultaneously introduced a second criterion for workability. The localiser legitimated the existing text on the basis of its length: it fit the available text space. He also refuted the validity of the originator's suggestion based on its length.

Though the counter-argument may in itself have been valid, it failed to address the originator's thesis on grammatical correctness regarding word order, and, thus, evaded the proposition (as an argumentative fallacy, similar to a "red herring" (Walton: 1999: 94). With this turn, the localiser displaced the significance of the originator's finding and problematisation. He, similarly, positioned the originator's alternate artefact solution (artefact 2) in contradiction with the original one (artefact 1). The following table lists the localiser's main strategies.

Localiser's positioning strategy, key elements	
Criteria for quality	Appropriate text length
Solution	Artifact 1 (no change needed)
Obstacle to displace	Artifact 2
Participants' current positions relative to this solution frame *** Included in frame** *** Excluded from frame**	 Localiser Originator
Main rhetorical & argumentative strategies used to assert positions:	Ethos (professional credibility) Logos (self-observed evidence) Creating new criterion (length) Evading the question (fallacy)

Table 11. Localiser's positioning strategy

By refuting the correctness of the other participant's solution artefact against respective and mutually exclusive criteria, the localiser and originator also allocated each other to opposing positions. The translator and tester, further posited artefact 1 and artefact 2 in polarised solution frames and aligned themselves with the frames accordingly. The report, hence, represented two separate technological solution frames, one centring on the issue of word-order, and the other on length.

Quest for closure via the quest to design a third artefact

The coordinator entered the discourse and repeated the localiser's response: "Your suggestions do not fit the current layout". This intertextual motion served to express explicit agreement with the localiser's viewpoint, the expert opinion (Walton 1997: 19) and strengthen the value of the criterion of length. The coordinator, however, refrained from voicing any first-person opinions on the matter. She also refrained from explicitly voicing any opinion about word order but did implicitly also agree with the originator's concern about grammatical correctness by assigning the report back to him (in the *More info* status) and requesting him to provide a proposal that would also fulfil the criterion of length.: "Do you have any other suggestions?"

By implicitly and explicitly agreeing with both concerns, the coordinator positioned herself outside the battle of the two rival frames. As an external and externalised gateway she, instead, tried to conjoin their concerns. The coordinator invited the originator to also accept the solution frame of length (as a prerequisite for achieving workable artefact) by commissioning (Ethos of authority) a new solution from him based on this criterion (act of stipulative and persuasive definition[53]). This attempt served as a proposal to amalgamate the two frames in the form of a new, third artefact (artefact 3). According to Bijker (1995: 279), amalgamation can take place when two or more equally strong technological solution frames exist[54]. The following table summarises the situation.

Coordinator's positioning strategy, key elements	
Criteria for quality	Appropriate text length and word-order
Solution	Artifact 3 (shorter text and new word order)
Obstacles to displace	Artifact 1 and artifact 2
Participants' current positions relative to this solution frame	
** * Included in frame**	Coordinator
** * Excluded from frame**	Originator and Localiser
Main rhetorical & argumentative strategies used to assert positions:	*Appeal to expert opinion (suggestion doesn't fit) *Ethos (authority to commission) *Stipulative and persuasive definition (defining a working object, and presupposing that others accept the criteria)

Table 12. Coordinator's positioning strategy

The report now contained three frames of correctness, with the third building on the idea of merging the interests of the first two. This served to position the coordinator and the third solution frame in between the other two and their respective spokespeople.

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[53] According to Govier (2010: 76), a stipulative definition specifies how a term will be used. The person putting it forward seeks to set out a certain usage for a specific purpose. E.g. it may be necessary to restrict the meaning of some notion for some practical purpose.

[54] Bijker elaborates further that with amalgamated frames, closure is, in turn, reached once the interests of both are combined (Bijker 1995: 279).

Artefact 3

Spokesperson: Coordinator

Length
+ word-order

QUALITY

Length   Word-order

Artefact 1   **Artefact 2**

Spokesperson: Localiser   **Spokesperson: Tester**

Figure 5. Positions of current frames and their key elements

Re-problematisation and interessement: second attempt

During the second attempt to invoke interessement, the originator refuted the validity of the localiser's counter-problematisation, and also rejected the proposal made by the coordinator to construct the third artefact claiming that the proposed artefact 2 did fit and later implicating empirical evidence for this claim as logos. He attempted to reinstate his original problematisation and solution by redesigning artefact 1 to accommodate for his solution proposal (artefact 2) suggesting that one word in the existing notification, which seemed to prevent his proposed artefact from fitting the space as such, be split on two rows. Bijker (1995: 76-77) uses the term *interpretive flexibility* to refers to the openness with which unstabilised artefacts submit to change as per different requirements. For the originator flexibility served as a strategy with which to retain the viability of his frame in the negotiation.

Originator:

EB 01.08.2007: text does fit if to use soft hyphenation. In our case 'polzo-'/пользо- needs to be moved from 4th to 3rd row, and 'vatelem'/вателем left in 4th row. So, 'dannyh' would perfectly fit in the 4th row.

Originator's positioning strategy, key elements	
Criteria for quality	Correct word order and appropriate text length
Solution	Artifact 2 (fits both criteria)
Obstacles to displace	Artifact 1 and Artifact 3
Participants' current positions relative to this solution frame * **Included in frame** * **Excluded from frame**	Originator Coordinator and Localiser
Main rhetorical & argumentative strategies used to assert positions:	Logos (referring to evidence and using it to redesign Artifact 1 to accommodate for Artifact 2)

Table 13. Originator's positioning strategy

Closure by redefining the anomaly

The attempt to invoke interessement towards the originator's frame was again refuted by the localiser. This time, the localiser rejected the significance of the originator's problematisation concerning word-order by asserting that both the originator's solution proposal artefact 2 and the original artefact 1 "mean the same and are correct". Via this analogy, the localiser displaced the significance of syntax, i.e. form and instead determined correctness to relate to semantics, i.e. meaning, This also served to refute the need to create a third artefact as proposed by the coordinator.

Localiser's positioning strategy, key elements	
Criteria for quality	Semantics
Solution	Artifact 1
Obstacles to displace	Artifact 2 and Artifact 3
Participants' current positions relative to this solution frame * **Included in frame** * **Excluded from frame**	Localiser Originator, Coordinator
Main rhetorical & argumentative strategies used to assert positions:	Analogy between artefact 1 and artifact 2 Introducing new criteria (semantics)

Table 14. Localiser's positioning strategy

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Re-problematisation: third attempt

The originator redirected the focus of workability back to the criterion of word-order by problematising the localiser's conception that the meaning of words alone was sufficient. The originator also refuted the localiser's counter-problematisation, which displaced the idea of implementing his solution proposal (artefact 2), due to the alleged lack of space. This time, the originator explicitly invoked support for his assertion by enrolling as his ally evidence, which comprised measurement results on available text space as indicated by a length check tool.

Originator's positioning strategy, key elements	
Criteria for quality	Word order, appropriate text length
Solution	Artifact 2 (fits both criteria)
Obstacle to displace	Artifact 1
Participants' current positions relative to this solution frame	
* Included in frame	Originator
* Excluded from frame	Localiser
Main rhetorical & argumentative strategies used to assert positions:	Logos (measurements)

Table 15. Originator's positioning strategy

Interessement and failed enrolment

This time, the originator succeeded in invoking interessement with the coordinator, who then took part in the investigation. With the aid of the length check tool, the coordinator checked what the situation was with available text space. She enrolled the resulting data in support of her assertion, which concluded that there would be too little space left over, i.e. 1 pixel with 209 out of 210 pixels being occupied if the originator's solution was implemented[55].

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[55] The measurement tools were not trusted to necessarily accurately match the outcome in the user interface. Thus space was usually left, just in case. The originator's artefact 2 did not seem a suitable solution, and, hence, the coordinator failed to be enrolled in the originator's frame.

Coordinator:

> 21.8.2007 <u>EK</u> on behalf of <u>SA</u>: Please see the attachment. According to the length tester there is free space, but the last row doesn't fit (209/210).

Interessement and enrolment: rhetorical escalation

Until this point the relations of power between the participants had been hidden. Next, however, these relations became disclosed as the frames, respective artefacts and participants became explicitly positioned.

The coordinator assumed the currently vacant role of error manager and enrolled the authority and power invested in it. This served to reveal the asymmetry that was organisationally, and by virtue of the error handling process, attributed to different power positions of different roles, and thus the subjects assuming them.

The coordinator positioned herself as the obligatory passage point (Callon 1986: 6)[56] for introducing alternate solutions to the anomaly (as artefact 1). Thus, the only way to get any change implemented would be to do what the coordinator suggested and construct a third artefact (artefact 3). In order to encourage interessement and enrolment into the third frame, the coordinator assumed the error managerial power, which was vested in the role by virtue of the process. This role included the power to decide on the error report's fate. She additionally applied her interpretation of the respective positions, powers and roles that she considered other participants to have. She positioned and cornered the originator as the one responsible for designing the third artefact addressing the request directly to him: "Do you have any shorter suggestions? If not, this will be ignored. Thank you!"

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[56] Obligatory passage points form channels through which other actors must pass in order to fulfil their interests (Callon 1986: 6).

The coordinator, in the error manager role, asserted her positioning power by appropriating a managerial discourse style. This was manifested in her threat to, otherwise, ignore the report and leave the original artefact 1 in place. These appeals to pathos (appealing to force[57]), and ethos (authority to determine dichotomous solution options, including that of ignoring report[58]) served to amplify the invitation to interessement and encourage enrolment of the other parties into the third frame.

The process ascribed the localiser as the one responsible for the creation of workable objects and implementation of quality. Here, the coordinator, however, assigned the role of quality creation to the originator, the tester, whose task was supposed to be that of indicating and investigating problems with existing artefacts. By assigning the tester the responsibility of designing the third artefact, the coordinator simultaneously positioned him as the possible obstacle for achieving good quality as specified in the third frame.

Not only had the originator's artefact solution become problematised, but, also, the originator himself had become positioned as an anomaly and the focus of managerial action and control. His quest for quality had been enrolled as an agent against himself. He was still, however, not only cornered as the obstacle for, but through the suggestion to create the third artefact, also the key to solving the issue with poor quality. The multitude of strategies and methods are summarised in table 16 below.

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[57] The premises of an appeal to force or harm express or instil fear. The related conclusion has to be accepted because bad things will otherwise happen (Govier 2010: 175.)

[58] An either-or split, which omits alternatives (Govier 2010: 213).

Coordinator's positioning strategy, key elements	
Criteria for quality	Word order, appropriate text length
Solution	Artifact 3 (with shorter text and new word order)
Obstacles to displace	Artifact 2, artifact 1, Tester
Participants' current positions relative to this solution frame	
* Included in frame	Coordinator
* Excluded from frame	Originator, Localiser

Main rhetorical & argumentative strategies used to assert positions:	Logos (measurements)
	Ethos (authority, decision-making power)
	  *Appeal to dichotomy (propose solution, or report is ignored)
	Pathos (threat)
	  *Appeal to force (ignoring report)

Table 16. Coordinator's positioning strategy

Enrolling the process and enrolling quality

The originator responded to the cornering attempt as an attack. He retaliated by enrolling and mobilising various inanimate actants with which to refute the attempt and assume the power to reposition himself and his role as a tester within the setting.

Firstly, he enrolled the error handling process as an ally. He questioned the coordinator's authority to distribute tasks and responsibilities differently than what the process specified in the opening of his passage: "first of all, I would like to remind about the report handling." This initiated an attempt to displace the positioning power she had assumed in the error managerial role against that of the process. The tester continued to reposition the parties by pinning the roles of the tester and localiser to the process. He did so, in practice, by clarifying the responsibilities each role had in the common quest to create a workable artefact. He denounced the responsibilities that had been assigned to him by the coordinator to create the third artefact and, hence, resolve the quality issue: "Tester's task is to find a mistake and give suggestion IF possible." He, instead, repositioned the localiser as the correct solution provider by elaborating that "It is up to the translator to give valid translation that fits into the given space and corresponds to grammatical rules."

Originator's passage in full:

> <u>EB</u> 21.08.2007: first of all, I would like to remind about the report handling. It is up to the translator to give valid translation that fits into the given space and corresponds to grammatical rules. So, the remarks like 'give suggestion or report would be ignored' is not correct (by the way, setting report to ignored will never improve the language quality at all). Tester's task is to find a mistake and give suggestion IF possible.

Secondly, he enrolled quality as an ally by claiming that siding with his concerns displayed a commitment towards improving quality, whereas siding with the attitude of the coordinator, being in general prepared to ignore the report, did not. He intertextually enrolled the assertion of the coordinator, i.e. by quoting it and framed it as incorrect: "So, the remarks like 'give suggestion or report would be ignored' is not correct" He, in effect, placed the different actors into contradicting positions towards quality by questioning the way their actions demonstrated commitment to constructing quality. This served as an act of counter-cornering, and with this act, the originator positioned himself as the obligatory passage point to achieving good quality.

The argumentation gained its force through appeals to pathos. Pathos was amplified with the support claim: "(by the way, setting report to ignored will never improve the language quality at all)." The claim appealed to pathos in two ways. Firstly, in relation to the subject matter of quality, a generalised cause-consequence relationship was depicted between the fate of the error report and the fate of quality. The current level of quality was presumed insufficient, and fixing the error would improve overall quality. However, if the report was ignored, this would ultimately lead to quality in general "never" reaching a sufficient level "at all". Additional absolutes, i.e. the negations "Never" and "at all" amplified and underlined the totality of the potentially resulting deadlock.

Secondly, in relation to the reader, the rhetorical power of the passage was political and ceremonial. It performed as both a value and action claim: it sought to make readers concerned about the problem, and provoked them to act on it by arousing fear about the future consequences of their actions (argument from harm). It was, especially, a challenge to those whom the originator positioned as responsible for the implementation of quality related solutions. Ignoring the report at that point would have exemplified a general disinterest in quality and its overall value.

The passage created a distinction between opposing subject positions towards quality, and the actors were compelled to choose their side. Quality conscious people were expected to side and identify with the originator's concerns and motives and take action accordingly. Additionally, the originator himself was now exempt from having to comply with and submit to the wrongly assigned role of problem-solver and having to take on the responsibility of providing solutions.

Now, finally free from the assigned roles and responsibilities, liberated from coercion, and safe within the boundaries of his self-proclaimed position, the originator chose to submit to the needs of the third frame, and abide the requests of the coordinator to partake in the problem solving. He enrolled himself into the frame. He ended the passage making, what was now, the voluntary and benevolent gesture of providing some alternate methods to resolve the problem. "...here are the suggestions for two particular strings:" The originator had been mobilised to fulfil the needs of the third frame.

Note 1:

English translation:

by another user in the db (abbreviation of database)

Original Russian text:

другим пользователем из БД

Note 2:

English translation:

by anoth\-er user of the db ("\-" makes it possible to divide text into two lines)

Original Russian text:

дру\-гим пользователем в БД

The table below summarises the final positioning strategy assumed by the originator.

Originator's positioning strategy, key elements	
Criteria for quality	Word order, appropriate text length
Solution	Artifact 3 (with shorter text and new word order)
Obstacles to displace	Artifact 2, artifact 1, Coordinator
Participants' current positions relative to this solution frame *** Included in frame** *** Excluded from frame**	 Coordinator, Originator Localiser
Main rhetorical & argumentative strategies used to assert positions:	Ethos (expertise on process, providing solutions) Logos (knowledge about the process) Pathos *Argument from harm (consequence of ignoring report) *Amplifying gut emotions 59 (with absolutes "never", "at all") *Argument of belonging 60 (Dichotomous positioning of parties around quality)

Table 17. Originator's positioning strategy

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59 Freeman (1988, as quoted by Walton: 1999: 86) attributed the method of appealing to "gut emotions" to the "grandstand appeal". The speaker "can't be sure that giving logically

Mobilisation and closure by designing a third artefact

The gesture of redesigning the third artefact served to bring closure. The artefact was considered to be fulfil the frames of syntactic correctness (form via word order) semantics, and length, amalgamating all explicated requirements as had been proposed by the third frame.

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convincing arguments will work, but he can be sure the audience has "gut emotions." (Freeman 1988, as quoted by Walton: 1999: 86).

[60] The rhetoric-of-belonging argument divides the audience into *believers* and *nonbelievers,* and excludes those who do not embrace the speaker's point of view from the valued group of believers. This comprises a negative tactic that discourages disagreement by implying exclusion from a group. (Walton: 1999: 217.)

4.8 Common themes

4.8.1 Quality construction as a discursive achievement

Quality construction was not simply a function of technological expertise but, to a great extent, an accomplishment of skilful rhetorical and argumentation. The application of power, resistance to it, and the ability to influence, or as Callon (1999: 71) says impose on, others using various discursive tactics came into play. Quality was in each error case a product of multilateral negotiations. These centred not only on the anomaly itself but also on the discursive products (decisions, evaluations, statements) of other participants.

Constructing quality in each case, whether when related to strategies of factualising, positioning or framing entailed the ability to employ appropriate rhetorical and argumentatative elements, and enrol relevant alliances, in support of one's strategies and goals. In this sense, key moments of translation (mobilisation, closure etc.), i.e. pivotal points during which action was either escalated or suppressed, where also moments that introduced new strategical and tactical elements.

4.8.2 Discourse styles in action

The elements participants employed did not seem randomly selected, rather they coincided with the respective roles of them. In relation to this, different roles appeared to link to the appropriation of specific discourse styles. The discourse styles, in turn, appeared to relate not only to roles per se, but also to the relationship between different roles, as mutually stratified points of reference.

The discourse style of roles invested with managerial power, i.e. the power to order, make conclusive decisions and finalise closure differed from the discourse style of roles where the role and respective input was void of such power being more explanatory in nature. The argumentation and rhetoric

participants of differently stratified roles utilised when factualising, positioning and framing differed similarly. For example, in situations of struggle over decisions, such as in the third analysis concerned with positioning, a defensive stance was visible in the discourse of the originator/tester role who refuted positioning attempts targeted at him. Expert discourse applied in the second analysis to influence decisions was also explanatory, not simply descriptive in style.

Longacre's (1996: 34) categorisations of discourse styles seem to be applicable to the discourse styles employed in the different roles in the error report material. Longacre refers to instructional and hortatory discourse as that which draws on authority, applies commands, and motivates using threats to influence conduct. This discourse type appears to coincide with the managerial discourse of error managers and project managers sand representatives. Expository discourse, which, according to Longacre, evaluates solutions using supporting argumentation, refrains from giving commands and imposing values, would appear to coincide with the engineering discourse of expert roles. However, during power struggles, when proposals for action and decisions for closure were being refuted, participants of any role, especially when in a situation of being dependent on the work or decisions of others or having to oppose decisions or orders or defending one's position, would seem to apply political and procedural discourse to influence decisions or directions. Political discourse aims at influencing and having others adopt certain values and beliefs, draws on supportive argumentation, e.g. authority or experience, proposes solutions or answers. Procedural discourse, in turn, employs and posits procedures.

5. CONCLUSION

This study looked at how the quality of technological artefacts became constructed through strategies of factualisation, framing and positioning within the error handling practices of the software development process in the organisation in question. It highlighted the multitude of skills and efforts that participants employed in the quality construction process. By focusing at the discursive micromechanisms of error handling in play, this study investigated and disclosed the ways participants in practice interacted and worked on the alleged anomalies in the quest to reach solutions to them.

Factualisation, positioning and framing strategies manifested simultaneously as social and discursive action. The study, thus, further investigated how methods of persuasion in the form of rhetoric and argumentation were utilised in the effort to achieve goals that would influence the direction in which the anomaly was shaped. Also the persuasive power of the social efforts of enrolment, as per the framework of translation posited by ANT, was elaborated.

The ANT process of translation helped identify the key moments, which influenced the direction of the anomaly's design in the quest to stabilise and reach fixity regarding conceptions of its workability. Working objects, i.e. artefacts that achieved closure through the process, were not simply, or solely, the result of adopting and implementing the best technological solutions, but also the result of appropriating those solutions which also fulfilled the socially most appreciated criteria. As such, they were also outcomes of social battles, struggles between different perspectives and voices, and in general, the outcomes of multilateral negotiations. Technological considerations gained influence to the extent that were empowered through discourse within the quality construction process.

When artefacts succeed in being accepted as workable, visibility to the social processes that were involved in their creation become obscured (Bijker 1995: 14-15). Thus, in the frame of the specific realm of technology development relevant for this study, the notion of quality was not, as Bijker (1995: 14) puts it, an intrinsic feature of an object, but a constructed one. Similarly as Bijker (Bijker 1995:14) concludes, at a general level, in this context also, technology change was contingent, depending on the social groups that partook in their shaping.

According to Konda et al. (1997: 331), the complex reality regarding the interrelatedness of the social and technical is underplayed by disciplinary allegiances. I would also say that visibility to and comprehension of this reality is similarly obscured in the actual field of technology development. Especially the significance or nature of social workings in reaching would help understand the way technical solutions are reached could perhaps help think whether this work could be done more efficiently. As Bijker clarifies, technological development is a result of heterogeneous engineering: A successful engineer is not only a technical genius, but also an economic, political, and social one. I would add, also a rhetorically talented one. A good technologist is, thus, a heterogeneous engineer (Bijker 1995:15 and Law 1987, as quoted by Bijker 1995: 15), or as to Konda et al. (1997: 331), frame it, an engineering sociologist.

The locus of action, i.e. the error handling database, formed and represented what Bijker (1995: 15) describes as a seamless web, where scientific, technical, social, cultural, and economic factors were present. These elements are mobilised and come together in discourse. The error handling process set up a field of action, or as Latour elaborates (1986:107), a network and a set of positions within which the anomaly gained meaning. It set rules for action, and as Callon (1999: 68) describes, defined margins of manoeuvre for the participants in respect to their assumed roles. In reference to Bourdieu's,

(1984: 94; 80) sociological metaphors, the error database constituted a field where participants enter with various knowledge capital, competence, and habitus invested in their dispositions. As Latour describes (1986:107), factity of the anomaly was relative to the network of meaning produced in this field.

Leverage for certain conceptions was gained through persuasion, argumentation and the act of enrolling participants, including inanimate ones, who brought along with them their supportive dispositions. This was quite visible in the case of the third analysis concerning positioning strategies, where the process itself become enrolled as an ally. The error handling process established a social order for this rhetorical community bringing technology and the community of animate and inanimate agents together.

According to Bijker (1995: 263), power is the apparent order of taken-for-granted categories of existence and these are fixed and represented in technological frames. However, in practice, this social order was not continuously stable or fixed. In the context of this study, procedural discourse within the error handling framework was simultaneously a field of social struggle and redefinition. The boundaries of rights and responsibilities and the limits of and rights to power were challenged and negotiated in the process. As Gurvich (1971: xv) summarises, in these situations, meanings and hierarchies were, at least temporarily, upset.

Perhaps a certain level of obedience, as Bijker (1995: 263) asserts, towards the initial order of dispositions in each case was visible and related to the specific discourse styles appropriated by representatives of specific dispositions and roles. In order to gain support for their personal and sometimes conflicting goals, participants, then, employed respective rhetorical and argumentative methods in skilful ways that also challenged otherwise self-evident seeming constraints of power, but still submitted to the set dispositions. For example, in the third analysis, positioning attempts by the coordinator, were questioned by the originator, by leaning on the process that determined the roles.

In situations of closure, which served to fix interpretations of the anomaly and its quality in place, power that was enacted as social power, figured also as semiotic power (Bijker 1995: 263). As this power made interpretations lose modality, and caused the anomaly disappear. It served to naturalise certain technological frames and the elated artefacts turning them into, what Bijker (1995: 263) calls them taken-for-granted categories.

To conclude, as Convey states (Bell and Mead, 1992, cited in Convey 1997: 32): "Design is a messy, ad hoc, atheoretical activity... Innovations come out of this "tussle with reality". "The design activity is immersed in practical concerns." Convey 1997: 32). Ultimately, the path from the drawing board to the end-user winds in many ways.

5.1 Implications for future research

This study is an appraisal of the impressive, and usually obscured skills and efforts that are mobilised in the process of constructing the quality of technology artefacts in the software development realm under study. It raises awareness about the social, sociological and discursive aspects involved in the respective practices of error handling. However, in the same note, this analysis also raises the question of whether the error handling setup as such is sufficient enough a system for ensuring and enhancing quality in an efficient and effective manner. A large proportion of the discourse in each report investigated in this study had less to do with actually solving issues with workability or dealing with technical or expert knowledge, and more to do with the efforts of participants to factualise, position, and frame personal and subjective notions about the anomaly's nature and importance (evaluating whether further action should be taken or not), and even the commitments and agendas of other actors. In contrast to this, as was lastly the case in the first report, gaining direct access to the analyses of a merited expert clearly seemed to boost the achievement of closure.

For future studies, disclosing the inner workings of human action in the software development realm further, for example, by investigating the motivations people claim to have for taking certain courses of action, such as promoting closure in decision-making, could help enhance the ability of quality constructing organisations to secure appropriate, and thus, efficient information flow in problem-solving situations and processes.

If continuing in line with this study, the framework developed and utilised here can be applied to material associated to any type of anomaly in any field of quality construction and error handling, as long as there is a chain of discourse to analyse. The only caution is that in order to figure out what is the most prominent strategical theme to investigate in each case, a sound pre-reading of the research material at hand is necessary.

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Internal references

Internal 1
Build process web page

Internal 2
Change requests web page

Internal 3
Internationalisation guide

Internal 4
Language variant testing web pages

Internal 5
Localisation guide

Internal 6
Quality assurance web page

Internal 7
True testing training powerpoint presentation

Internal 8
Error management process powerpoint presentation

Error reports

Internal 9
Device becames slow when using IMAP mailbox that is connected to an UNIX
shell account.
15-Dec-2006

Internal 10
Calendar: wrong word order in notes for Calendar database conflict
27-Jul-2007

Internal 11
Browser NG: buttons are inactive on message creation page of Yahoo Japan
mail
14-Dec-2006

APPENDIX 1: EXAMPLE ERROR REPORT

Textual content of the error report analysed in Case 1.

Note 1. Names of people, projects, units and other identifiers have been obscured to protect their identity by replacing them with underlined texts or descriptions.

Note 2. Original formatting of the text (e.g. bolded font) has been retained.

Error Report

ID: 123-456
Status: 8. CLOSED
Severity: High
Priority: SHOW STOPPER

Originator's name
on 14-Dec-2006 at 09:40

Unit Name Rel x.1 Browser NG: buttons are inactive on message creation page of Yahoo Japan mail

Description:

14.12.2006 K.M.

Preconditions and set-up information:
Device used for testing

Precondition: Browser NG is opened with http://mail.yahoo.co.jp

Steps:
Step 1. Login using valid ID and password
Step 2. Select [Create message (メールの作成)]
Step 3: Type e-mail address to [To:] field then press [Send (送信)] button

Expected Result:
[Send] button functions

Actual result:
Send button is inactive

Other buttons [Save to draft(下書きフォルダに保存)], [Spelling check(スペルチェック)], [Cancel(キャンセル)] and [Attach file(ファイルを添付)] are also inactive

Note:
Checking on Variant 1 is not done, as this is a variant specific web page

Attached: probe_YahooJPMail.log

Repro in Rel x.1 wk48 V16 (Japanese) on R

Comments:

14.12.2006 T.L: I, please re-test with x.1m NB on Z and x.2 CCB NB on R. If this is not reproducible,

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please try to reproduce with <u>Unit name x.2</u> wk48 Variant 16 release build on <u>R</u>.

14.12.2006 <u>I.S.</u>
<u>T</u> ask the originator to provide the username and password to the email account to verify the bug. Can't verify it without this info.

14.12.2006 <u>T.L</u>: <u>I,</u> I believe we have yahoo mail account. Please check with <u>P.</u>

14.12.2006 <u>I.S.</u> can't login with US Yahoo username. Please provide Japan User Id and password to verify the bug.

15.12.2006 <u>K.M</u>: Repro in <u>x.1</u> wk50 V16 (Japanese) on <u>R</u>.
I created a account for Yahoo Japan. Here is the info:
ID: <u>123-456</u>
Password: <u>abcdefg</u>
E-mail address: <u>address</u>@yahoo.co.jp

15.12.2006 <u>I.S.</u>
<u>x.2</u> NB dec14 build based on wk 48 <u>R</u>
not able to reproduce a problem

18.12.2006 <u>K.P.,</u> Browser EM: To be retested on the latest <u>x.1m</u> nightly build with <u>Z.</u>

12/18/2006 <u>R.F.</u>: reproducible on <u>x.1m</u> nightly build with <u>Z.</u>

18.12.2006 <u>K.P.,</u> Browser EM: This is not reproducible in <u>x.0m</u> with <u>M</u> hw. So this is regression from <u>x.0.</u> To <u>S</u> for further investigation.

19-Dec-2006 <u>V.P.B.</u>:
From above comments:
<u>x.2 R</u> NB wk48 - Not Reproducible
<u>x.1 R</u> (Japanese) wk50 - Reproducible
<u>x.0m M</u> - Not Reproducible
My findings:
<u>x.1 R</u> NB wk48 - Not Reproducible
I can send an email from <u>R</u> to my <u>abcde</u> account from mail.yahoo,co.jp....

21-Dec-2006 VPB:
Retested on <u>R x.1</u> NB
Retested on <u>R x.1</u> RnD
Retested on <u>Z x.1</u> RnD
Retested on <u>Z x.1</u> NB
Not reproducible on all builds. I can send email from mail.yahoo.co.jp to my <u>abcde</u> email. I tried sending email with attachments, no text in body, and text in body. Used both "send" buttons, top and bottom.
Retested <u>Z</u> builds with <u>R</u> present to verify the testing and it was not reproducible.

21.12.2006 <u>K.P.,</u> Browser EM: Ignored.

15.01.2007 <u>K.M.:</u> Repro in <u>x.1</u> wk02 fix1 Variant 16 (Japanese) on <u>R.</u>

18-Jan-2007 <u>K.P.,</u> Browser EM: Retested using <u>S</u> (<u>S</u> nightly build browser dated 18-Jan-2007 10:16:12 GMT from <u>web page address</u>). The issue is not reproducible
I have loaded http://mail.yahoo.co.jp, page was loading fine and email was sent successfully, I don't see any issues (including square blocks or not working send button etc.,).

22.01.2007 <u>K.M.:</u> Issue is still repro <u>in x.2</u> wk02 fix1 V16 (Japanese) on <u>R.</u> In message creation screen, buttons are overlapped and inactive. See screenshot <u>Error report ID x.2wk2.jpg</u>.
This error is NOT repro in Variant 1 English. On Variant b1 English, although the buttons are

overlapped and text on the page is garbled, buttons on the message creation screen are active and message can be sent.
Issue is repro also in x.1 wk2 fix5 V16 (Japanese) on R.

29.01.2007 K.M.: Repro in x.1 wk4 V16 (Japanese) on R. In message creation screen, buttons are inactive and message cannot be sent. Please note that this issue is not repro in Variant 1 English.

01-Feb-2007 K.P., Browser EM: To be retested using Unit name x.1 wk04 v16 (Japanese variant) build.

Feb. 2, 2007 H.L.: tested with Unit name x.1 wk04_004 v16 (Japanese variant) build on R, this bug is reproducible.

02.02.2007 T.L.: This problem can be produced on x.1, but not x.2 CCB. Removed the bug from x.2 as affected party list.

05-Feb-2007 K.P., Browser EM: To be retested using Unit name x.0 wk04 v16 (Japanese variant) build with M hw.

07.02.2007 K.M.: This error is reproducible on x.2 wk4 Variant 16 (Japanese) on R. Buttons are inactive on message creation screen. Adding x.2 for affected parties.

07-Feb-2007 K.P., Browser EM: x.0 variant builds are no longer available to check for regression. To webcore team for further investigation.

12-Feb-2007, Browser ECB: Set to Not Active. Browser will not be available in the Japan market.

13.02.2007 W.C. (Company name EM) : Set back as To Be Evaluated. According to Company name Variant EM, Unit name Browser is not dropped for the Japanese market.

16.02.2007 L.P. - Proposed for Customers to check this for their PR schedules. According to our testers there is a high risk that this error will in practice affect the maturity experienced by end users.

<16.02.2007, Project name IRB: >Prioritized by Project name Program. Targeted to Project name PR2.0.

26.02.2007 K.M.: Repro in x.1 wk8 fix1 V16 (Japanese) on R.

08.03.2007 I.T.: Repro in x.1 wk10 V16 (Japanese) on R. In message creation screen, buttons are overlapped and inactive.

14.03.2007 D.S.: The Operating system name charConv function ConvertToUnicode returns a special character (165) for backslash "\" (92) when the charset is "euc-jp". The yahoo japan compose page has javascript that contains the backslash characters & as a result the parsing fails. Attached is a sample html file used to debug the issue. This is a Operating system name issue.

14.03.2007 T.L.: Moved to Operating system name. This problem needs to be fixed on both z.2 and z.3.

19.03.2007 A./Rel x.1 Operating system name error Telco: Operating system name needs more info:
Hi,

Can you please provide more information on how to reproduce the issue and add a call stack?

With the information provided, it is difficult to pinpoint the problem.

thanks,

20.03.2007 A./Rel x.1 Operating system name error Telco: New defect in <u>Tool name</u>.

20.03.2007 <u>A.H.</u>: See discussion below, change cannot be done in <u>Operating system name</u> code. If this error needs to be corrected, suggesting some sort of a hack in charconv. Changes in java srcipt are not preferrable

Hi,

Realistic solution, which is often used in Japanese environment, would be to display a yen sign for a 0x5c (backslash) in browser, provided that charconv can be changed to convert 0x5c to 0x5c rather than 0xa5.

If charconv cannot be changed, the JavaScript interpreter needs to be changed, I think. How much control do we have in the JavaScript interpreter ? Can it be changed to interpret 0xa5 as 0x5c, for example ?

Br,
<u>M.</u>

_____

From:	<u>Email address</u>
Sent:	19 March, 2007 08:48
To:	<u>Email address</u>
Cc:	<u>Email address</u>
Subject:	<u>Error report ID</u> <u>Unit name Ax.1</u> Browser NG: buttons are inactive on message creation page of Yahoo Japan mail

Hi Guys,

Please take a look at the browser bug. I think this is something we should react now as the problem was analysed to be releated to charconv. Unfortunately, this is the known issue of overlapping backslash and Yen sign.

<u>Operating system name</u> cannot fix this as <u>Unit name</u> has branched charconv. I don't think it could be fixed in our version of charconv either as it works as specified.

Any suggestions?

Br,
<u>V.</u>

21.03.2007 <u>M.I:</u> This problem cannot be solved simply in charconv. If charconv is changed, **does Browser commit to change** to display 0x5c as the yen sign in Japanese pages ?

Or is there some other solution possible ?

22.03.2007 <u>A.</u>/Rel <u>x.1</u> Operating system name error Telco: Operating system name having problems reproducing this. If we have branched charconv. should this be investigated together with <u>Operating system name</u> so that they don't make fix "in vain" in case we will not use it anyway. Please comment to <u>Tool name</u> in case this problem is in <u>Unit name</u> code.

26.03.2007 <u>A.H.</u>: According to <u>Vs</u> email above the correction cannot be done in <u>Operating system name.</u> Also, changes to browser code for this are not possible (no sound solution so far identified). Adding <u>S.</u> as responsible, can you answer <u>M's</u> question.

<u>H.</u> **29-Mar-2007:** Japanese CharConv -><u>Company name</u>

01 Apr 2007 S.Y.: Changing JS Interpreter is not possible for such a specific case (it is an open source component). <u>Operating system name</u> can change to return 0x5c for "\" and can also change text drawing to display yen sign for Japanese font. Any solution in Browser domain would be a hack and will cause performance problems in Japanese env since we have to check each character while drawing text/after character conversion. I ll check on Monday if any other solution is possible.

2-Apr-2007 <u>J.K.:</u>
Reported problem with Yahoo Mail is also reproducable with <u>S Operator name</u> using <u>Application name</u> Browser to access <u>http://mail.yahoo.co.jp</u>. It is apparently not any recent regression.

The original solution (since <u>Unit name w.6</u>) for converting Shift-JIS/ISO-2022-JP/EUC-JP codepoint 0x5C to 0xA5 in =>Unicode conversion has been done for this purpose:
To support displaying (half-width) Yen symbols in Japanese web pages using Yen symbol rather than backslash. Showing them as backslash in web pages is unacceptable.

Changing conversion tables for Shift-JIS/ISO-2022-JP/EUC-JP => Unicode to convert 0x5C to 0x5C would bring old problems/errors back so it's not a good solution as the only solution to this problem.

Also changing Japanese fonts to show Yen in place of backslash would be a problematic solution as well, as that would make in impossible to handle input/rendering of real backslash character in Japan variant products also in use cases where Japanese encodings are not used at all.

If code conversion table is going to be modified, additional solution is needed to make Browser support Yen symbol rendering on Japanese web pages (should be linked to source encoding information).
Also all other use cases where backslash/yen can be used that involve conversions between Japanese encodings and Unicode need to be retested / re-evaluated (such as vCard, vCalendar etc.).

In this Yahoo Web Mail client's mail sending source page where problem occurs no instances of 0x5C can be found. I saved the page using Firefox and attached here as "Compose.htm".
It seems that instances of 0x5C appear in linked files that contain JavaScript code, such as:
http://i.yimg.jp/lib/pim/r/medici/12_27_02/mail/compose.js?20070201 (attached as Compose.js).
The linked files containing JavaScript code seem to be US-ASCII compatible, there are no Japanese text strings there at all.

Questions:
- Which component is running the encoding conversion for JavaScript content?
- Is the whole JavaScript code going through the conversion process or is it just the portions that are defined as text strings inside JavaScript content?
- Should JavaScript code be parsed so that escape codes would be parsed first before converting encodings?

05.04.2007 <u>M.I.:</u> The Browser team's answer for the above questions:
Here are the answers to the questions:
- We use char conv for encoding conversion. The call is made when content arrives (HTML/inline JS). In case of external scripts, conversion is done when the script is accessed.
- The whole JS content goes through the conversion process.
- Inline JS is processed through the char conv before the script node is created. External script is handled slighty differently.

For clarification, the requirements for Browser are:
- If the page encoding is Shift-JIS/ISO-2022/EUC-JP, 0x5c should be rendered as a yen sign in Browser and should work as backslash in JavaScript.
- If the page encoding is Unicode, U+005c should work as a backslash and U+00a5 should work as a yen sign.

The current solution proposal is:
- Change charconv to convert 0x5c to U+005c only when it is called from Browser.
- Browser and JavaScript interpreter render backslashes as yen signs when the page encoding is Shift-JIS/ISO-2022/EUC-JP.

Actions to take:
- Company name to make an experimental change in charconv and send it to to the check the behaviour with the modified charconv.
- If it is successful, Company name and Browser deliver the fix for x.2 first.
- When testing is done for x.2, Company name and Browser make fixes for x.1.

Question:
Is the NameID of Browser number string ?

12.04.2007 O.P. (Unit name EM): Priority upgraded to Show stopper. Multiple x.1 products about to ship and very negative feed-back to be expected from Japanese market unless solved.

17.4.2007:S.K.J: Urgent issue, please act accordingly.

17.04.2007 M.I: Browser seems to work OK with the solution proposal above. Company name is delivering the fix for x.1 and x.2 as proposed.

23-Apr-07 A.L. (S EM)
Added S as Affected Party.

23-Apr-07 T.I. (Operator name Tokyo EM): Added Operator name Japan on Affected party. This error fix is crutial for our future products for Operator name.

23-Apr-2007 S.M.: similar problem here? S Version number @ [http://wap.oa.yahoo.com]
Number string

24 April 2007 S.Y.: W, can you comment your test findings with the ZIP file that M sent?

April 24, 2007 W.L.:

With the zip file patch that M provided, I was able to verify that it fixes the yen problem in test page that S asked me to test and also on yahoo jp site. Per Ss request, reassign this bug to MI for he's the provider of the fix.
  In a quoted character string in Javascript,
  "\\" is rendered as ONE yen sign
  "\n" is rendered as a newline, no yen sign

  0x5c is converted to yen in Shift-JIS/EUC-JP.

25.04.2007 M.I: Please also assure that "\\" in JavaScript is rendered as a Backslash if the page encoding is Unicode. Company name has delivered the fix for x.1 and x.2.

30 April 2007 S.Y.: W, can you check this also?

   08.05.2007 K.M.: x.1 wk18 fix1 is not released yet. Verification will be done when the corrected build becomes available.
   With wk18 (both x.1 & x.2), there is a problem that browser is redirected to wrong page if http://mail.yahoo.co.jp is tried to be reached. This problem is reported in Error report ID

   08.05.2007 K.M: Verified with x.1 wk18 fix1 V16 (Japanese). Confirmed that mail could be sent from Yahoo! mail service. Due to the related error (Error report ID) user now need to first login to Yahoo! Japan, then go to Yahoo! mail service to send a message. Message containing Japanese characters was sent and received with Outlook OK.

09.05.2007 K.M.: Checked with x.2 wk18 V16 (Japanese) on R. Buttons are active on this build, however, when loading the message creation page, an error message appears say

"memory full, try again after closing some applications", even though the only active application is a browser. And if [send] button is pressed, message is sent, but before the browser goes to the next page, a crash occurs and browser closes. The same issue was repro in x.1 wk18 but not repro in x.1 wk18 fix1.

09.05.2007 K.M.: Checked with x.2 wk18 fix1 V16 (Japanese) on R R. "memory full" problem and crash after pressing the [send] button is repro on this build.

12.5.2007:S.K.J: Please deliver the fix for x.2 as well. **(M.I.**)

14-May-07 T.I. (Operator name Japan): Solved save conflicts.
Operator name Japan set to Corrected since x.1 has already have this error correction. We will check it when we have Project name Japanese variant based on PR2.0.

22-May-2007 S.U./Company name: This task is not in Unit name wk18. Will be in Unit name wk20 build.

07-June-2007 M.K./ Company name: Fix is integrated in S wk22 Version number. Set S to RELEASED.

11.06.2007 I.T.: Tested with x.2 wk22 fix 1. "memory full" problem and crash after pressing the [send] button is NOT repro on this build.

12.6.2007:S.K.J: Closed referring to **I.T.** comments.

21-Hun-2007 E.C.: Verified with S wk24 Version number.

28-Jun-2007 T.I.(Helping S) : Set S to Closed

2-Aug-2007 T.I. (Project name Operator name EM): Set Released on Project name SB. R, would you please arrange the verification? thanks.

3-Aug-2007 S.O.: Verified with Project name Operator name .(Version number)

14-Aug-2007 T.I.(Project name Operator name EM) : Set Closed on Project name Operator name.

19-Sep-2007 P.S. (Company name/EM, Tampere):
Project name IRB closed.